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ARSENIC IN PRIVATE WELLS IN NH

YEAR 2 FINAL REPORT

Public Health Contract

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INTRODUCTION

In New Hampshire (NH), 46 percent[i] of the population depends on private wells for their water supply at home.[ii,iii] The Safe Drinking Water Act does not grant the U.S. Environmental Protection Agency (EPA) federal or state authority to regulate private wells in the same manner as public water supply systems, nor does the NH Safe Drinking Water Act grant such authority to a state agency. Thus, unless local authorities have enacted regulations, the onus is on individual households to undertake regular testing for drinking water contaminants and to apply treatment as necessary.

Arsenic is a contaminant found in untreated well water that is of particular concern.[iv] Arsenic is a Class 1 carcinogen[v] and it ranks number one on the 2013 Priority List of Hazardous Substances published by the Agency for Toxic Substances and Disease Registry.[vi] Based on the potential adverse effects of arsenic on the health of humans and the frequency and level of arsenic occurrence in public drinking water systems (and the level that may be achieved with the use of the best available technology), the EPA has set the arsenic maximum contaminant level (MCL) for public drinking water systems at 10 parts per billion (ppb).[vii]

Past studies in NH estimate that a relatively high number of private bedrock wells contain concentrations of arsenic exceeding the MCL.[viii,ix,x] The southeastern region of the state has the greatest potential for arsenic concentrations greater than or equal to 5 ppb and 10 ppb (Figure 1). There may be 41,000 people in just the counties of Merrimack, Strafford, Hillsborough, and Rockingham that are drinking water with arsenic levels above the EPA standard.[xi,xii]

Despite the risks of both immediate and life-long health effects posed by arsenic in well water, testing seems not to be a top priority for those households with private wells. While there are relatively few studies of testing rates, the studies that have been performed suggest that a significant percent of households are unaware of the

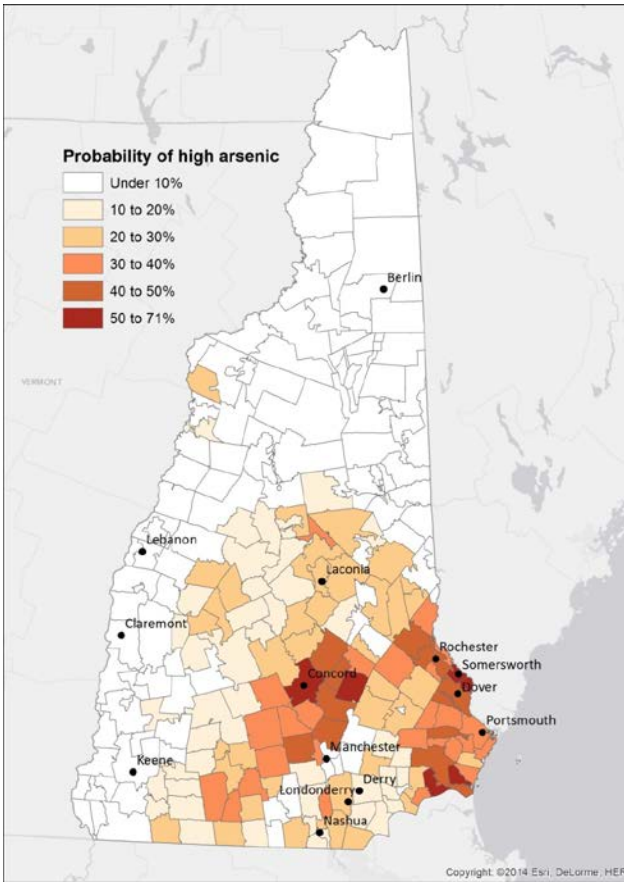


Figure 1: Geographic distribution by ZIP code of the probability of arsenic in well water exceeding 10 ppb, as estimated by the USGS model.[9] Prepared by J. Chipman.

need for regular water quality monitoring.[xiii]

Among those who do test their water and find high levels of arsenic, many still do not take mitigative action, such as whole house or point of use water treatment.[xiv] Installation of a water treatment system is a multifaceted process that can be confusing or overwhelming for private well owners. Most systems also require long-term upkeep and maintenance. Taken together, this situation suggests a need to better understand the barriers to well water testing and treatment and the opportunities for state and local health officials to provide meaningful and actionable information.[xv]

The goals of this report, therefore, are to:

1. Provide an overview of the work we completed in Year 1 to survey private well owners to: estimate rates of well water testing and treatment for arsenic; identify factors influencing the rate of water testing and treatment; evaluate the effectiveness of a New Hampshire Department of Environmental Services (NH DES) flyer in encouraging water testing; identify subpopulations that are less likely to test and treat their water; and determine the types and maintenance of water treatment systems being used. In addition to the survey, we developed estimates of statewide well water arsenic exposure and health effects and selected three types of interventions to be pilot tested in Year 2 based on the results of our survey.
2. Report on the Laboratory Data Storage System that we developed to accept and store data provided by private laboratories and the DHHS Public Health Lab which were recruited by NH DES. The system will assist with effective evaluation of the rate of well testing in the state based on active outreach and intervention efforts.
3. Describe the selection of towns and implementation of interventions. We will report on the results of the pilot testing of these local interventions as a means to evaluate whether, how, and when to implement more extensive and costly statewide initiatives.
4. Summarize our insights, based on the results of this two-year effort, relative to barriers to testing and treatment and methods to increase private well testing and treatment in New Hampshire.
5. Describe a community toolkit, based on our evaluation results, which will be available statewide. The toolkit will include outreach materials, methods to determine the type of intervention that would be effective for private well owners in that community, and sample worksheets.

These goals will be addressed in the sections that follow. Based on the analysis and evaluation of the year two interventions we conclude with the identification of questions that have been raised by this project that provide opportunities for future investigation, and which we hope

will lead to future cumulative actions to increase private well testing and treatment to improve public health in New Hampshire.

OVERVIEW OF YEAR 1

Our major objectives for Year 1 of the project were to: hold a set of focus group meetings to get an overview of experiences and attitudes regarding water testing and treatment, design and distribute a survey of private well owners, analyze the survey data to identify the factors affecting well owners' decisions regarding well water testing and treatment, and estimate statewide exposure to arsenic in drinking water from private wells and associated health risks.

Focus Groups

We conducted focus groups in March 2014 with residents of four New Hampshire towns: New London, Barrington, Goffstown, and Londonderry. The purpose of the focus groups was to test the concepts and assumptions forming the basis of our survey questions and to deepen our understanding of the knowledge, attitudes, and behaviors of NH well users. In total, 31 people participated in the focus groups. Among the participants were a town manager, a town administrator, two health officers, two building inspectors, a real estate agent, a code enforcement officer, planning board members, a director of public works, and a diverse group of residents. Some of the key findings from the focus groups were:

1. Participants associated well water quality with taste, smell, and appearance, and many felt that high amounts of one or two contaminants did not reduce the overall quality of the water;
2. A majority of participants recalled testing their water during a real estate transaction, but many had not tested since that time.
3. Participants identified cost, inconvenience, and lack of awareness as the major barriers to regular water testing;
4. Among participants that had water treatment systems, the primary reason for installing a water treatment system was to address aesthetic issues.
5. None of the participants with a treatment system had tested their water after their system was installed;
6. Cost deterred participants from treating their water; and
7. Each group suggested that their town websites would be the best place for information about water testing recommendations.

Survey

We created a custom survey instrument in April 2014 with the aims of estimating rates of well water testing and treatment for arsenic, identifying factors determining the rate of water testing and treatment, evaluating the effectiveness of mailing an NH DES flyer in encouraging water testing, identifying subpopulations that are less likely to test and treat their water, and determining the types and maintenance of water treatment systems being used. The final survey was implemented online in Survey Monkey. We created a postcard with a link to the survey and a cover letter that appeared on the first page of the survey site. Depending on the respondents' answers to questions concerning testing and treatment, the survey contained between 31 and 40 questions.

Four groups of private well users in NH were invited to participate in the survey: 5,800 randomly selected addresses from a list of 49,866 addresses with wells (171 surveys completed); 1,471 addresses that received a mailed NH DES flyer on well water testing (48 surveys completed); general public NH residents with a well (550 surveys completed); and individuals testing their well water during May-August 2014 at a public or private lab in NH (56 surveys completed).

Survey Data Analysis

Key summary statistics from the survey include:

1. Eighty-two percent of respondents drink their tap water "always" or "frequently."
2. The most common groups with whom respondents have had a conversation about the safety of well water are water treatment companies (34%); friends, neighbors, or co-workers (33%); realtors (22%); home inspectors (22%); and state officials (16%). Many respondents (20%) have not spoken with anyone about the safety of well water.
3. Among the 80 percent of respondents who test their water, there were several findings. The most common time since testing is 3-10 years ago (29%). The strongest considerations for testing were "I wanted to know if the water was safe to drink" (77%) and "I had it tested as part of a real estate transaction, or a real estate agent recommended it" (40%). Sixty-five percent reported testing for arsenic, giving an overall arsenic testing rate of 52 percent. The arsenic testing rate corresponded geographically with areas with a greater probability of high arsenic. The most common concerning test results were arsenic (24%), iron (20%), and radionuclides (19%). Seventy-four percent of respondents initially understood the test results they received from the lab. Another 22 percent understood them after getting further help. Sixty-four percent of respondents initially understood what actions they should take in response to the test results. Another 21 percent understood what actions to take after getting further help.

4. Among the 20 percent of respondents who did not test their water, there were several findings. The most common reasons for not testing were "I meant to have it tested but never got around to it" (42%), "I didn't know how to go about having it tested" (38%), "The water looks, smells, and tastes clean" (33%), "I have not had any health problems caused by drinking the water" (28%), and "The testing costs too much" (25%). The most common conditions which would prompt respondents to test their water were a change in the taste, smell, or appearance of the water (81%), hearing that a neighbor's water had problems (70%), hearing that other wells in town had problems (63%), a coupon for a discount on a water test (61%), a mobile testing lab visiting their town (60%), and seeing a news article about a water quality problem in the area (59%).
5. Among the 67 percent of respondents who treat their water, there were several findings. The types of systems people employ include (some employ more than one): water softener (41%), sediment filter (37%), iron filter (18%), pitcher filter (16%), carbon filter (15%), reverse osmosis system (12%), radon water treatment (10%), arsenic treatment system (9%), aeration (5%), adsorption filter (5%), green sand (2%), anion exchange (3%), and ultraviolet (UV) disinfection (2%). Thirty-five percent treat because they had the water tested and the results indicated it should be treated. Thirty percent treat because the water tasted, smelled, or looked bad. Thirty-five percent treat for a variety of other reasons. Thirty-nine percent have never tested their water since starting to use their water treatment system, and 21 percent test only rarely (about every 5-10 years).
6. Among the 33 percent of respondents who do not treat their water, there were two main findings. Forty-six percent have had their water tested, and the results suggested there was no need to treat. Sixteen percent believe a treatment system is too expensive or difficult to install, use, and maintain.

We used our survey results to construct a diagram depicting the estimated 'flow' of surveyed well owners through the 'process' of well water testing and treatment. This type of flow diagram, in which the width of the lines is shown as proportional to the flow quantity, is referred to as a *Sankey* diagram, named after its original creator. In this diagram and in subsequent analyses, we distinguish between those well owners from ZIP codes with a greater (and, respectively, less) than 15% average probability of arsenic concentrations above the MCL of 10 ppb, based on the USGS report, *Estimated Probability of Arsenic in Groundwater from Bedrock Aquifers in New Hampshire*, 2011. Key points to be taken from our Sankey diagram (Figure 2) are that:

- Almost 40% (165 out of 440) of well owners from higher risk arsenic towns who are having their water tested for arsenic are receiving test results that are 'concerning' to them.

- About 6% (5 out of 80) of well owners from lower risk arsenic towns who are having their water tested for arsenic are receiving 'concerning' test results.
- About 40% (310 out of 750) of well owners from higher risk arsenic towns have not tested their water for arsenic.
- Only about half (145 out of 270) of the respondents who treat their water and state that their intent is to remove arsenic actually have treatment systems that are effective at arsenic removal. However, most of those who are correctly treating (90 out of 145) are those who received concerning arsenic test results. Most of those who are incorrectly treating their water are those who have not had their water tested for arsenic.
- Numerically, the number of respondents who are incorrectly treating their water (120 out of 1000) is larger than the number who have found high levels of arsenic in their water but are not treating it (70 out of 1000) and comparable to the number who have not tested their water but might be expected to have high levels of arsenic (about 135 out of 1000).

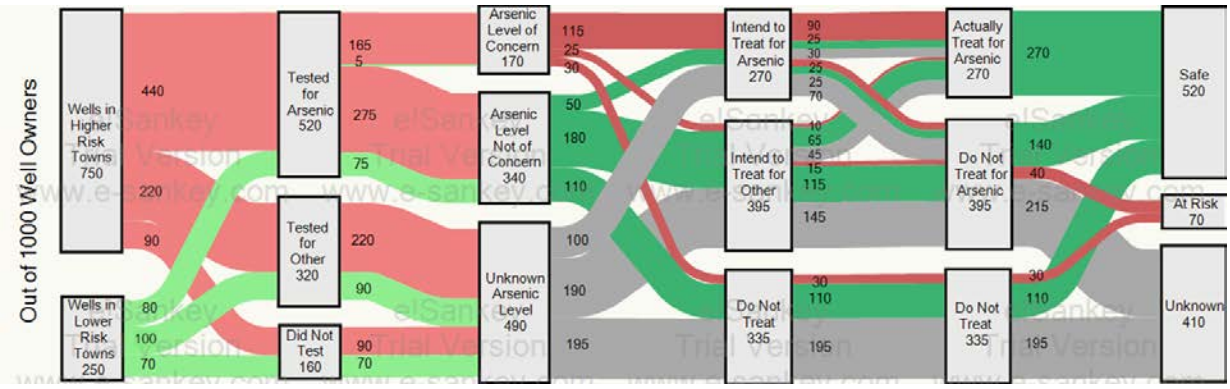


Figure 2: Sankey diagram showing the estimated flow of well owners through the multi-stage process of well water testing and treatment. Boxes represent possible states corresponding to various possible survey responses, with the number of well owners in each state (out of a hypothetical 1000 survey respondents) indicated within each box. Flows between states were derived from cross tabulation tables of the corresponding survey responses scaled to represent 1000 total well owners. Light red and light green flow lines indicate those well owners from ZIP codes with a greater (and, respectively, less) than 15% average probability of arsenic concentrations above the MCL of 10 ppb. Dark red and dark green flow lines indicate those well owners with water test results indicating a level that was (and, respectively, was not) of concern to them. Grey flow lines represent those well owners who have not tested their water for arsenic. All values are rounded to the nearest five.

A more detailed multivariate analysis using Classification and Regression Tree (CART) models showed three subpopulations of concern due to a combination of high arsenic risk and low *test* rate: non-white residents, residents of a multi-family or seasonal home, and residents with a single-family home who did not talk to friends or family about water quality. Our analysis also showed two subpopulations of concern due to a combination of high arsenic risk and low *treatment* rate: people with arsenic test levels of concern who do not understand what action

to take and people with arsenic test levels of concern who understand what action to take, live in a town with a high maximum probability arsenic level, and have an income less than $75,000. We also analyzed the rate of water "mistreatment," which is the instance of people treating their water and stating that their intent is to remove arsenic but who report having treatment systems, such as water softeners, that are not effective at arsenic removal. We identified those who did not test their water for arsenic and who did not talk to anyone about water quality, including a water treatment company, as having especially high mistreatment rates. Among those who did test their water for arsenic and found levels of concern, the mistreatment rate is highest among those who did not talk to a water treatment company when choosing their treatment option.

The above analyses provided us with important information used in developing intervention strategies for Year 2 to overcome barriers to well testing and treatment. After consultation with the project Technical Advisory Committee (TAC), it was determined that we would pursue three types of local interventions: Town Communications, Intercept Campaigns, and Testing Events (see "Selection of Interventions" section below).

Exposure and Health Risk Assessment

We estimated the health impacts of arsenic in untreated or inadequately treated private well water in New Hampshire. We took as the basis for our analysis the series of EPA Integrated Risk Information System (IRIS) reports on the cancer risks of oral arsenic exposure. These reports are intended to synthesize the toxicological and epidemiological studies available at that time. EPA published its first IRIS assessment of inorganic arsenic in 1988, with a revision in 1998. An update to this assessment was initiated in 2003 and implemented recommendations from two National Research Council (NRC) reports (1999 and 2001). Subsequent revisions to the IRIS assessment are still considered to be in draft form and unable to be cited. Thus, we relied exclusively on the 1998 IRIS revised assessment and the 1999 and 2001 NRC reports, all of which are publicly available.

The data contained in these reports suggest that the risk to the current population of untreated private bedrock well water drinkers in NH due to exposure to an average arsenic concentration of 7 ppb corresponds to an estimated 830 lifetime incidences of bladder, lung, and non-melanoma skin cancers. If water from all private wells containing greater than 10 ppb arsenic could be treated down to a level of 10 ppb, roughly 451 lifetime cancer cases could be avoided among the current NH population (Figure 3). Acting on, and treating to, a threshold level of 5 ppb would avoid an estimated additional 154 cancer incidences.

It is important to note that more recent research has also identified non-cancer health effects that were not included in our analysis because the applicability to the NH population is uncertain. This trend is consistent with the fact that, over the last 25 years, the number of diseases associated with arsenic has *increased*, the locations associated with arsenic mediated disease have *increased*, and estimates of what constitutes a safe long-term arsenic dose have *decreased.* For this reason, we believe that our estimate based on information available at the time of the 2001 NRC report is more likely to underestimate health effects in NH than overestimate them. This is consistent with the expectation that the current draft IRIS guidelines are likely to lead to a further increase in the estimated cancer risk rate. Thus, we conclude that our estimate of 451 potentially avoidable lung, bladder, and non-melanoma skin cancer cases is likely a lower bound on a very uncertain estimate of the full health impacts of exposure to arsenic in well water in NH.

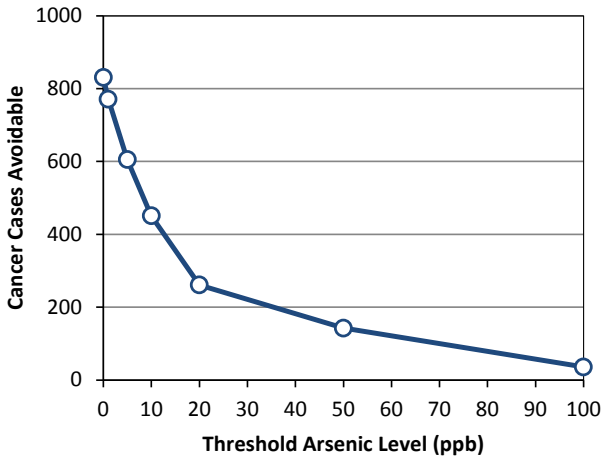


Figure 3. The estimated number of bladder, lung, and non-melanoma skin cancers avoidable by removing arsenic from well water down to a range of threshold levels from 0 to 100 ppb.

LABORATORY DATA STORAGE SYSTEM

As a means of monitoring the impact of efforts to increase private well testing statewide, NH DES recruited a number of private laboratories, in addition to the NH DHHS Public Health Laboratory, to voluntarily report weekly private well testing volumes, beginning in June of 2014. In order to support this data gathering effort, we have implemented a lightweight, loosely coupled, and extensible system through which laboratories can report testing activity in a form that is convenient to them. Essentially, labs specify the testing activity by week, associated with

	A	B	C	D	E	F	G	H
1	**Name of Laboratory:**	Example Lab						
2	**Week Number**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
3	**Dates**	June 1-7	June 8-14	June 15-21	June 22-28	June 29-July 5	July 6-12	July 13-
4	**Name of Test Package**	Number of samples handled						
5	Basic	5	8	6	3	4	2	
6	Comprehensive	5	3	12	11	14	18	
7	Bacteria	5	2	5	3	2	5	
8	Food License	1	2	1	1	0	2	
9	Radon	0	1	6	4	3	5	
10	VOA	0	0	1	1	1	0	
11	VA/FHA	0	0	2	1	0	0	
12	Lead	0	1	2	4	2	0	
13	Arsenic	1	3	2	1	7	1	

	A	B	C	D	E	F	G	H	I	J
1	**Name of Laboratory:**	Example Lab								
2	**Date:**	7/11/2014								
3		**Name of Test Package or Single-Parameter Analysis**								
4	**Analyte**	Basic	Comprehensive	Bacteria	Food License	Radon	VOA	VA/FHA	Lead	Arsenic
5	Arsenic		X							X
6	Bacteria	X	X	X	X			X		
7	Chloride	X	X							
8	Copper	X	X							
9	Fluoride	X	X							
10	Hardness	X	X							
11	Iron	X	X							
12	Lead							X	X	
13	Manganese	X	X							
14	Nitrate	X	X		X			X		
15	Nitrite		X		X			X		
16	pH	X	X							
17	Sodium	X	X							
18	Radon					X				
19	Uranium									
20	Analytical Gross Alpha									
21	VOCs						X			
22	SOCs									

Figure 4. Examples of spreadsheets provided by labs. Top: weekly data by package; bottom: a description of analytes associated with each package.

named packages. They provide a spreadsheet with two tabs: one with weekly data by package (Figure 4, top) and a second with a description of analytes associated with each package (Figure 4, bottom).

A single R script then produces an Excel file containing the data from all labs for all weeks and all analytes. It will also produce a graph in PDF format that shows for which weeks data were received from which labs (Figure 5).

An additional R script uses the file produced to create stacked bar charts showing various breakdowns of the data by lab, analyte, and week (Figure 6). It also produces an Excel workbook that includes tables (corresponding to the plots) which may be of interest.

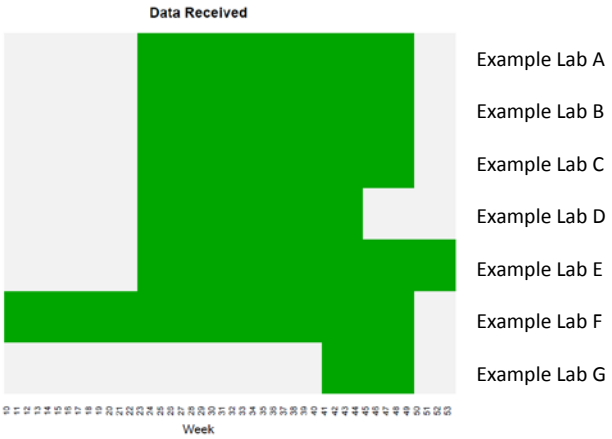


Figure 5. Graph matrix showing for which weeks data were received from which labs.

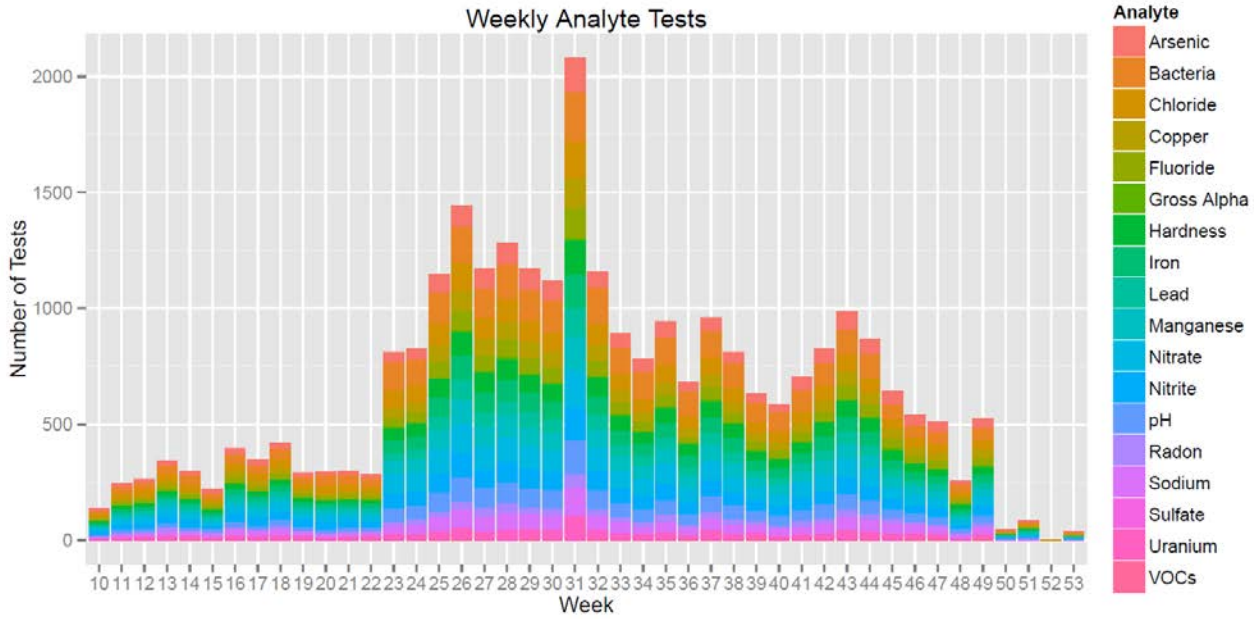


Figure 6. One of the stacked bar charts produced showing the number of tests of each analyte by week.

The chief advantage of this system is that labs can specify packages as they choose, and add new packages as needed. The system takes advantage of Excel and electronic mail. There is no need for commercial software and there is no webserver to build or maintain. Labs may submit

data any time. The Excel spreadsheet produced can be readily loaded into a database or analyzed in a statistical program.

Limitations

The system uses Excel, which allows free form data entry, but the script that aggregates these spreadsheets requires highly structured data. A human being must therefore perform rudimentary quality control on Excel spreadsheets, and further errors may or may not be detected by software that transforms spreadsheets into a unified data stream. A human being must then perform further analysis to assess data completeness and check for other errors.

The system expects a single spreadsheet from each lab covering all weeks for the entire period. The current software does not detect duplicated or missing data.

Certain aspects of the Excel input are sensitive to errors. For example, each package referenced in the data tab of a given lab's spreadsheet must perfectly match (including white spaces) a package description listed in the packages tab of the same spreadsheet. Missing values, blanks or random text in the data tab may cause the system to behave in unexpected ways.

Deliverables

At the completion of this project, we provided:

1) An R script that reads and aggregates properly formatted Excel data to produce the merged file described above.
2) An additional R script that uses the merged file to produce plots expected to be of most interest, as well as an Excel file corresponding to these plots.
3) A short “user’s manual” in the form of a step-by-step README file that describes the required directory structure and how to employ the R scripts.

Use for Assessment

Unfortunately, data contained in the data management system do not provide information on the location of the tests performed. Further, as the system was implemented as part of this project, it does not provide information on the numbers of tests performed in previous years. Therefore, it is not itself useful for assessing the success of our interventions performed in Year 2. As a result, our evaluation of Year 2 interventions relies solely on DHHS Public Health Laboratory data. We assume that local private labs may have seen a corresponding increase in testing, but this cannot be verified.

SELECTION OF INTERVENTIONS

The analyses presented in the previous sections provide us with essential information to achieve the ultimate goal of reducing the risk of adverse health effects to private well owners in NH exposed to arsenic and other contaminants in untreated or inappropriately treated drinking water. At the end of Year 1, we proposed an intervention strategy designed to overcome the barriers to well testing and treatment identified in our focus groups and statewide survey. We chose to focus on interventions at the local level, because of their potential for replication across multiple communities and their ability to serve as pilot projects for more extensive statewide efforts.

Based on a comparison of six possible local interventions using nine key criteria, we recommended implementation of three selected local initiatives: Town Communications, Testing Events, and Intercept Campaigns:

Town communications: Provide state-of-the-art communications on testing and treating private well water via town-level channels (e.g., town mailings, bulletin board or kiosk, listserv), utilizing select board members, town managers, and health officers to identify effective ways to distribute information to town residents.

Testing events: Establish 'well testing days' which bring the testing kits to local residents by working through a community board (e.g., planning board, conservation commission) to establish a specific day to hand-out testing kits. Work with the community board to publicize the testing event. To distinguish the effects of cost and convenience, the tests conducted through these events would not be discounted or subsidized.

Intercept campaign: Partner with local offices or community-based organizations to intercept people at specific popular places within the community such as the transfer station, general store, local market, farmer's market, or churches to inform them about the need to test and potentially treat their private wells. Utilize staffing from a public health contractor to train representatives from these local partner organizations to greet and inform people from a table-top or standing display which would include education and awareness materials (messaging and materials would be provided). One-on-one conversations would be encouraged, and actual well-owners from the community with experience testing and treating their wells would be recruited as display 'greeters.' Depending on location, coffee and donuts or other snacks could also be provided.

Further, we proposed that these be implemented according to a 'blocking' approach to experimental design in which a total of six towns are recruited for participation and each of three different interventions is implemented in four different towns (Table 1). If arranged correctly, this allows all combinations of every two interventions to be duplicated. Strictly speaking, this approach requires 'random' selection and assignment of towns to the various

intervention 'treatments', as well as independence of towns with respect to the effect of interventions. We recommended seeking to meet these assumptions to the extent practically possible.

Table 1. Experimental design of the application of interventions to towns. Shading and X's indicate towns where the indicated intervention is applied.

Intervention	Town					
	1	2	3	4	5	6
A	X		X	X		X
B	X	X		X	X	
C		X	X		X	X

TOWN SELECTION PROCESS

Selection Criteria

After completing the intervention selection process at the end of Year 1, we next identified potential towns ready for intervention implementation. According to estimates provided by the USGS, the southeastern region of New Hampshire is statistically more likely to have private wells with a higher concentration of arsenic, therefore our first selection criterion was to limit the towns under consideration to the southeastern region of the state.

Pre-Readiness Screening

After reducing our geographical area of focus, we identified community screening criteria to vet southeastern towns. The first two key criteria were based on the USGS report, *Estimated Probability of Arsenic in Groundwater from Bedrock Aquifers in New Hampshire, 2011*. They were:

- The probability of a town having an arsenic average above 10 parts per billion
- The number of people served by wells

Filtering towns through these two criteria, we were able to identify towns with a high probability of elevated arsenic levels and a high number of private wells. These two criteria combined were measured as overall assessment of risk. We selected the 16 towns with the highest overall assessment of risk. The 16 towns were, in no particular order:

1. Londonderry
2. Goffstown
3. Weare
4. Derry
5. Bow
6. Pelham
7. Bedford
8. Hudson
9. Hooksett
10. Barrington
11. Stratham
12. Hollis
13. Loudon
14. New Boston
15. Windham
16. Epsom

We then identified 10 additional screening criteria that would help identify current town engagement around issues relating to private well water:

- Does the town have a champion or leader on this issue?
- Does the town have an existing ordinance regarding arsenic in well water?
- Was a Year 1 focus group held in the town?
- Does the Dartmouth Toxic Metal Superfund Research Program have an existing relationship with the town?
- Does the NH Department of Environmental Services have an existing relationship with the town?
- Are there other external indicators that might have bearing on this project?
- Is the community connected to a regional public health agency?
- Has the town expressed an interest in participating?
- Is the town already working on this issue with another group/agency?
- Is the town being engaged through the NH DES MtBE program?
  (MtBE is a gasoline additive. NH DES has been conducting a voluntary private well water testing program in some areas of NH.)

We then conducted informal research to find answers to the screening criteria. This research included, but was not limited to; outreach to town officials, review of town websites, discussions with state and regional experts, review of local news outlets, and review of past and current community efforts led by DTMSRP and NH DES. Once research was completed each town was given a point for each screening criterion it met. For example, the town of Londonderry received one point for hosting a Year 1 focus group. Of the 16 towns vetted, eight towns had scores of seven points or higher while the other eight towns scored a 4.5 or lower. Based on the scoring divide we decided to narrow our focus to the eight towns with scores higher than seven. The eight towns selected were, in no particular order:

- Londonderry
- Goffstown
- Derry
- Bow
- Pelham
- Epsom
- Barrington
- Windham

These eight towns were further screened using an abbreviated Community Readiness assessment.

Introduction to Community Readiness

The Community Readiness Model (CRM) was developed by researchers at the Tri-Ethic Center for Prevention and Research[xvi] [xvii]. CRM is used to assess how prepared a community is to address an issue. If a community is not ready to address an issue it can be more difficult to engage partners and create lasting change. This lack of readiness should be considered when choosing interventions. Conversely a community with a high level of awareness, or ownership, will be more prepared to address this issue in a long-term, comprehensive way. We utilized a modified Community Readiness Model to help finalize the town selection process, assess current activities and to establish relationships with town partners. We did not have time to engage in as many key informant interviews as recommended in the original CRM.

The Community Readiness Model identifies nine stages of community readiness:

Stage One	No Awareness	Community has no knowledge of local efforts addressing the issue
Stage Two	Denial/Resistance	Community has incorrect knowledge about the issue
Stage Three	Vague Awareness	Some community members acknowledge the issue but are unsure how to act
Stage Four	Preplanning	Some community members acknowledge the issue, and that action needs to be taken to address the issue
Stage Five	Preparation	Community is concerned about issue and acknowledge that the community needs to address the issue
Stage Six	Initiation	Community members start to take action to address the issue
Stage Seven	Stabilization	Ongoing community effort to address the issue
Stage Eight	Confirmation/Expansion	Community participation is high and community resources are allocated to continue to address this issue
Stage Nine	High Level of Community Ownership	Most segments of the community are involved, highly supportive and knowledgeable about the issue

The original CRM helps a community to look at an issue in an in-depth way and identify potential interventions to address said issue. We had already identified our local interventions, so we used CRM interview results to gage overall town readiness or awareness of the issue and to learn more about community engagement around the issue.

Community Readiness Interviews

The original model suggests interviewing 6-8 key informants. While it was our goal to interview 6-8 per town it became obvious that setting up and completing 6-8 interviews in eight towns would take several months. We had 6-8 weeks to complete our interviews. We decided on 3-5 interviews per town. The CRM interview script addresses five key dimensions:

•Community Knowledge of the Issue
•Community Knowledge of Efforts
•Community Climate
•Leadership
•Resources

Through existing relationships with key informants in our eight towns and "cold calling" we invited over 70 people from the eight towns to take part in our readiness interviews over eight weeks. We completed and transcribed 21 interviews in total. We targeted a variety of individuals to participate including:

- Members of town government
- Members of community organized environmental groups
- Existing partners
- Public health officials

Scheduling interviews proved to be challenging. Most interviewees were invited 2-3 times to take part before responding to a request. Interviews took place around the schedules of the interviewees and included evenings and weekends. The interview script included 41 formal questions and 20 additional probes. Interviewee responses varied greatly - from a community member who has taken the time to study private well water quality to an elected official with no knowledge of the subject - there was great variety within our small interview pool. This disparity speaks to the varied engagement and limited knowledge of the topic in general.

The town of Goffstown was eliminated from consideration after numerous outreach attempts to 10 different community stakeholders. Potential interviewees either declined to be interviewed or simply did not respond to numerous interview requests.

Scoring and Town Selection

To finalize the town selection process we reviewed interview responses to eight key questions. These questions reflected the current and future capacity to address the issue, represented all five sections of the interview script, were somewhat measureable as interviewees were asked to provide a numerical answer, and were a mixture of open ended and closed questions. The eight key questions were:

1. Are there **any efforts** in town that address arsenic in private well water?
2. Using a scale of 1-10, how much of a **concern** is arsenic in private well water to the **leadership** of (town), with 1 being "not a concern" and 10 being "a very great concern"?
3. Would leadership **support additional efforts** in the community to address arsenic in private well water?
4. Using a scale of 1-10, how much of a **concern** is arsenic in private well water to the **community members** of (town), with 1 being "not a concern" and 10 being "a very great concern"?
5. Do community members believe **additional efforts** are needed?
6. On a scale of 1-10 where 1 is no knowledge and 10 is detailed knowledge, how much do you think community members **know** about arsenic in private well water?
7. What resources are available to address arsenic in private well water? Specifically: **Volunteers**
8. What formal or informal **policies, practices, and laws** related to this issue are in place in your community?

Once these eight key readiness questions were identified three DTMSRP staffers reviewed interviewee responses to each question and scored them from 1-10 with one being lowest and 10 highest. Questions 1, 7, and 8, having to do with current community efforts and status were weighted more heavily during the analysis, as it would have an immediate effect on summer interventions. Question 5 was weighted "more lightly" because the information, while informative, was moot if the interviewee did not have community-wide knowledge. The rest of the questions were assigned medium weight.

Based on review and scoring by DTMSRP staff six towns were selected for engagement:

- Londonderry
- Bow
- Pelham
- Barrington
- Windham
- Epsom

The town of Derry was eliminated because of its relatively low readiness score and the fact that the DTMSRP has additional research efforts planned for the town of Derry.

Intervention Assignment

At the end of Year 1 it was concluded that we would implement three different types of local interventions: **Town Communications, Intercept Campaigns and Testing Events**. Each town would implement two interventions. This allows all combinations of every two interventions to be duplicated. Based on community readiness results, replicability of each intervention, and somewhat random selection we selected the following interventions for each town:

Town	Town Communication	Intercept Campaign	Testing Event
Barrington	X		X
Bow	X		X
Londonderry		X	X
Windham		X	X
Pelham	X	X	
Epsom	X	X	

Incorporating readiness results and experimental design was expected to increase the likelihood of learning from the interventions during this grant and help in the effective design of future interventions/campaigns.

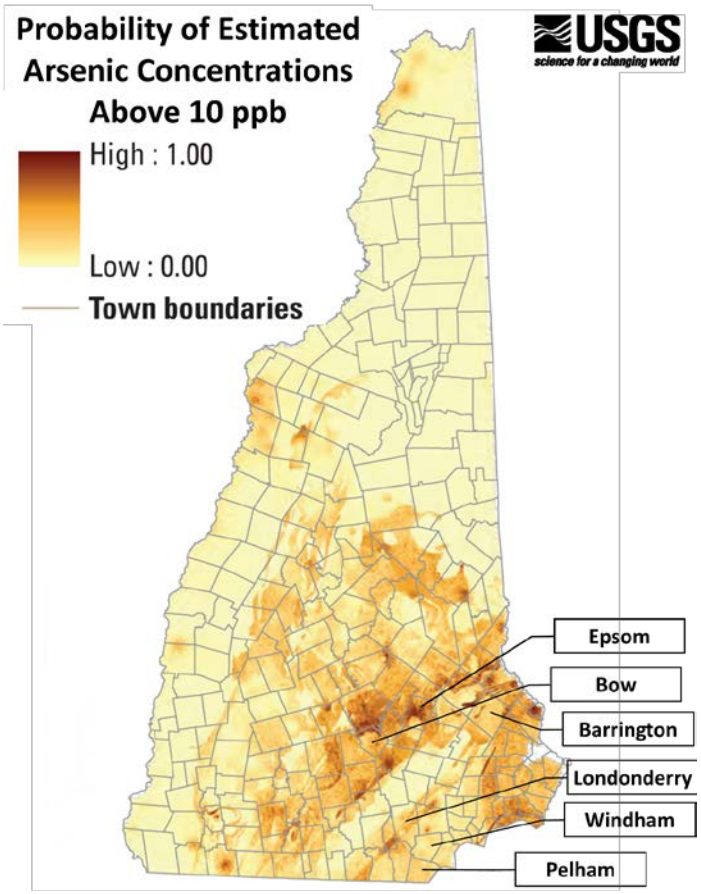


Figure 7. Location of intervention communities relative to the probability of arsenic in well water exceeding 10 ppb as estimated by the USGS model.

COMMUNICATION MATERIAL DEVELOPMENT

Introduction and Background

The Community Health Institute (CHI) was contracted to create intervention material and market test the material among the intended audience. The purpose of the market testing was to identify factors that influence the target group, NH homeowners with private well water, in getting their well water tested for arsenic as well as to assess their reaction to four message themes and four visual themes each designed to increase awareness about the need for and intent to voluntarily test their well water. Specifically, the focus group was used to collect feedback on:

1. Factors that impact individuals' practices in getting their well water tested;
2. Reactions to message concepts, persuasive techniques and the elements of style including color, photographs, general layout, font and objects,
3. Perceived key message of the sample material; and,
4. Assessment of a trustworthy logo that represents a credible source of information for this audience.

The four ***visual*** themes assessed were:

1. Infographic: Using icons and quick facts.
2. Professional Public Health: Using equal parts photo and text, with an "advertisement" look.
3. Photo Journalism: Using multiple photos to attract attention and show risk.
4. Testimonial: Using a single person and attributed quote to personalize concerns and outcomes.

The four ***message*** themes assessed were:

1. Risk of Exposure: Conveys likelihood of exposure.
2. Health Risks: Emphasizes impact on health.
3. Social Norm: Conveys that arsenic is common and everyone is in the same position.
4. Barrier Resolution/ Solutions: Emphasizes action steps that lead to self-efficacy.

Objectives

The focus group line of questioning assessed two primary objectives and one call to action:

Objective 1 The factors that motivate homeowners to get the recommended water analysis.

Objective 2 Determine the degree to which the sample material motivates the intended audience to increase their readiness to screen their water.

Call to Action Test your water today, and then every 3 to 5 years.

The following is a summary of CHI's focus group findings and recommendations, provided with the goal of providing image, content, and delivery method guidance to DTMSRP in the development of awareness material aimed at homeowners with private well water.

Methodology

CHI was responsible for developing the line of questioning for the focus group guide, research objectives, and all the recruitment materials (i.e. fact sheet of frequently asked questions explaining the purpose of the focus groups, risks/benefits of participation and their role, poster, sign-in sheet). Additionally, CHI developed a workbook for focus group participants to score each sample poster on a five-point Likert scale (1 = poster was not motivating and 5 = poster was very motivating) and to record their thoughts and comments.

CHI conducted the three focus groups in April 2015. The discussions were recorded and summarized. Participants were assured the recording was to be used for note taking purposes and then deleted. The notes are a general summary and not a verbatim transcription of the discussion. To encourage open and honest reflection of the topic discussed, participants were assured of the confidentiality of the discussion and that the findings would be reported in aggregate without attributing comments to specific individuals.

Limitations

The research has several limitations. First, the research is a snapshot of the attitudes and beliefs of the participants and cannot be generalized to the population, nor is it predictive of the sample population. The research can draw conclusions only about the groups targeted for participation and not about subgroups with cultural or ethnic differences. Overall, the sample size is too small to generalize. Second, the majority of the participants were recruited by responding to a poster or direct request from a staff person and were offered an incentive to attend. In other words, these participants may be more motivated to participate by the incentive and in turn are different in some way(s) than general NH homeowners. The last limitation to note is the gender of the groups. The majority of the participants were women.

Regardless of the limitations stated above, a level of saturation was achieved in which similar themes were expressed by participants across focus groups. The fact that similar themes emerged from the small sample size validates the use of focus group results in the creation of our communication materials.

Participant Recruitment

The focus group recruitment was based on a convenient sample; not based upon a randomization of the target population. Groups were scheduled in the towns of Haverhill, Epsom and Bow, NH. Participants learned about the opportunity through networks of contacts that CHI reached out to as well as communications in community areas such as libraries, town

buildings, convenience stores and schools, as well as posts on social media. In the end, a total of three focus groups with 21 participants were held. Participants received a $30.00 gift card to Wal-Mart or Target for their time and travel to the group.

- Haverhill, April 13: 8 participants
- Epsom, April 22: 9 Participants
- Bow, April 28: 4 participants

Summary of Findings- Part 1

The focus group script was developed to assess the two primary objectives (1) assess the factors that motivate homeowners to get the recommended water analysis and (2) determine the degree to which the sample material motivates the intended audience to increase their readiness to screen their water for arsenic. After a quick introduction, the facilitator asked the following open-ended question:

Question: What do you know about arsenic in well water?

Current attitudes and practices towards testing:

- General sense of confusion as to whether participants had their water tested for arsenic in the past. About half of participants knew whether they had it tested for arsenic, and half knew they had their water tested for something, which may or may not have included arsenic.
- All participants who had tested their water, indicated it was between five and 40 years ago when they bought their homes.
- One participant tests regularly.
- Many were not sure if or when they had tested for arsenic specifically.
- People noted that they just wanted to know if their well water is okay or not-- too many details to know.
- Simply never thought to test for arsenic.
- "Ignorance is bliss."
- Might be more willing to test now that we know it is a health issue. Did not know it was a health concern years ago.
- Might test if water tasted funny – that would be a trigger-- but it tastes fine, so most don't worry.
- One participant just learned that arsenic poisoning can have similar symptoms to cystic fibrosis.
- It was in the news recently that wine from California has surprisingly high levels of arsenic.

- Some participants were skeptical about why arsenic is coming up now-- “is this just the latest thing someone wants to sell you?”
- Several participants shared “Old Wives Tale” solutions to well water issues that many people still believe such as adding bleach or chlorine to the well.

Question: Why haven’t you tested, recently or ever?

Reasons for not testing:

- Never thought about it.
- Nothing seemed to change with my water and we had no symptoms, so did not realize we should be testing regularly.
- Have not experienced any ill effects.
- Did not realize that things could change in my water over time.
- Water tasted and smelled fine.
- [Local vendor] advertises on their sign to test. Not sure we trust them – is there really a problem or are they trying to sell me something. They want to sell an expensive water system. It is like when you bring your car in and you leave with a big expensive repair.
- It is expensive to fix it and it might not be necessary. Not sure we trust the company who does the testing. They might be trying to sell it.
- Need a fact sheet of good questions to ask so we can be good consumers and to not get taken advantage of.

Suggestions for Reminders:

- Have the lab send a reminder to folks who have tested in the past to remind them it is time to test again.
- If the septic system company can remind you to have your tank pumped, why can’t the water guy?
- If you have a system, then that company should send you a kit every 3 -5 years to remind you.
- Create an arsenic registry.
- Doctor could remind you to get tests.
- Test with life events (marriage, pregnancy, new home, grandchildren, etc.) but this may not be frequent enough.
- Test when children change schools (i.e. preschool to elementary, elementary to middle, etc.)

Summary of Findings- Part 2

The second part of the focus group was designed to identify participants' reaction to 12 sample visuals and four message themes developed by CHI. Participants were asked to share what they liked and did not like about each.

Qualitative Feedback

Participants received a paper booklet with 12 visuals. They were asked to critique all aspects of the visuals including graphics, fonts, headlines, and overall appeal. The facilitator asked the group each time, "What do you like about this poster and what would you change?" Participant feedback for visual and message themes, along with their quantitative motivational scores, are summarized in the following pages. Many comments and ideas were commonly threaded across all focus groups, so repeated comments are only reported once with a qualifier describing that many participants shared that idea.

Quantitative Measurement

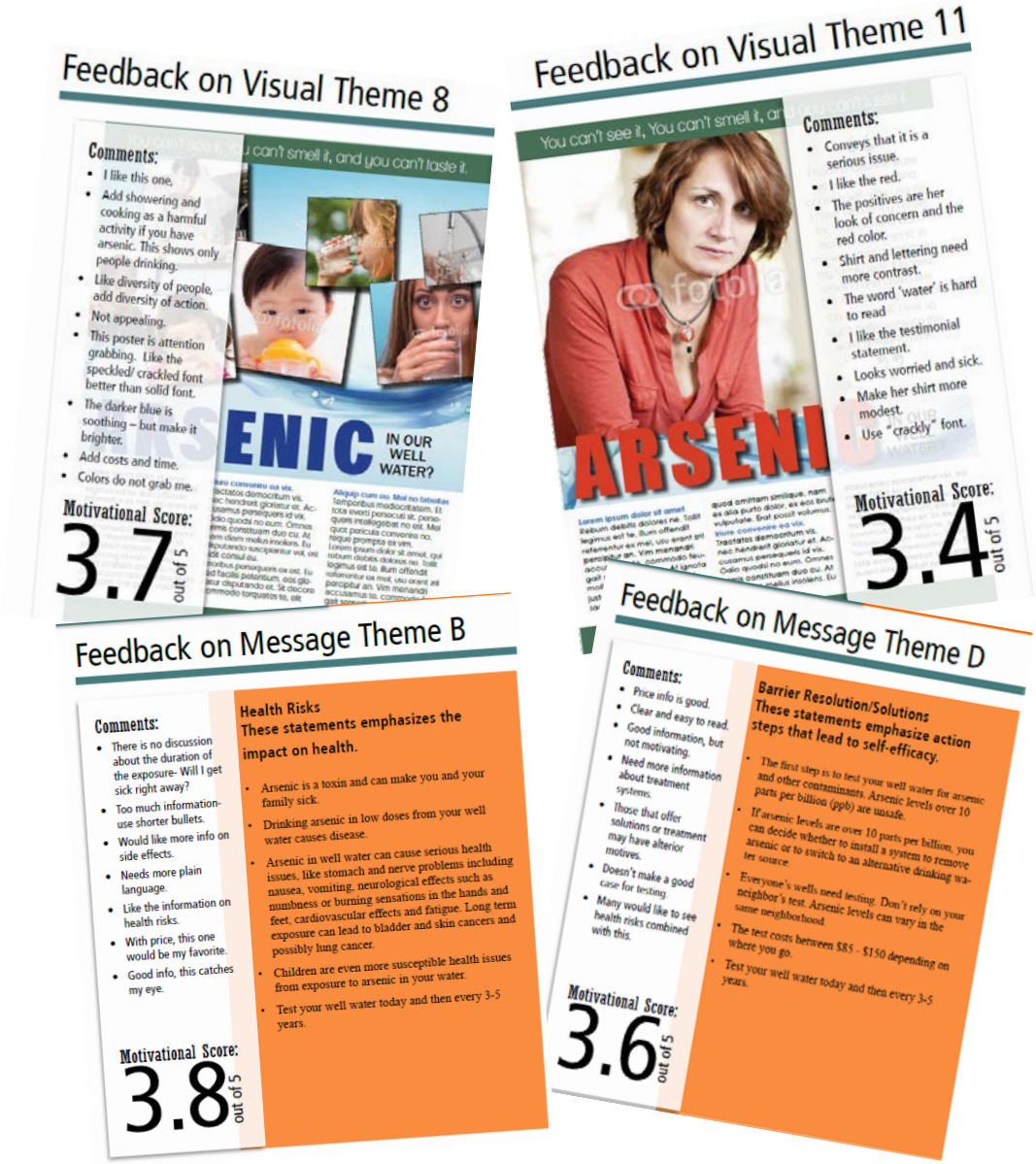
Participants were asked to rate on a five-point Likert scale (1=not very motivating and 5=very motivating.) whether each poster motivated them to have their water tested for arsenic. The motivational score for each visual theme and message theme is included in the commentary on subsequent pages.

As a final activity during the three groups, participants were asked to indicate their three favorite posters (based on image, motivation, and overall appeal) by writing a number 1, 2, or 3 on the poster. Visuals chosen as first favorite with a "1" were given three points, "2" were assigned two points, and "3" were assigned one point. The highest scoring options are starred ★ below.

Option	Average Motivational Score (1= not motivating, 5=very motivating)	General Appeal Score (Total score, 1st = 3pts, 2nd = 2pts, 3rd = 1pt)
Visual Theme 1	3.3	10
Visual Theme 2	3.0	9
Visual Theme 3	3.0	4
Visual Theme 4	2.8	4
Visual Theme 5	3.0	7
Visual Theme 6	3.3	14
Visual Theme 7	2.1	1
Visual Theme 8	3.7 (STAR)★	24 (STAR) ★
Visual Theme 9	2.4	0

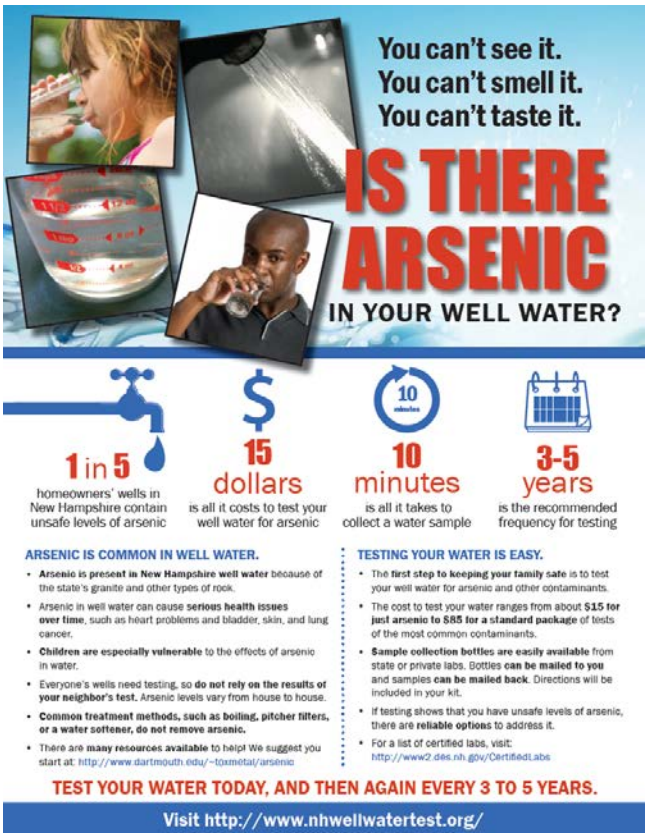
Visual Theme 10	2.3	5
Visual Theme 11	3.4 (STAR) ★	28 (STAR) ★
Visual Theme 12	2.5	5
Message Theme A	3.4	General appeal scores for message themes were not collected, as information from different themes was determined to be appropriate for inclusion.
Message Theme B	3.8 (STAR) ★	
Message Theme C	3.4	
Message Theme D	3.6 (STAR) ★	

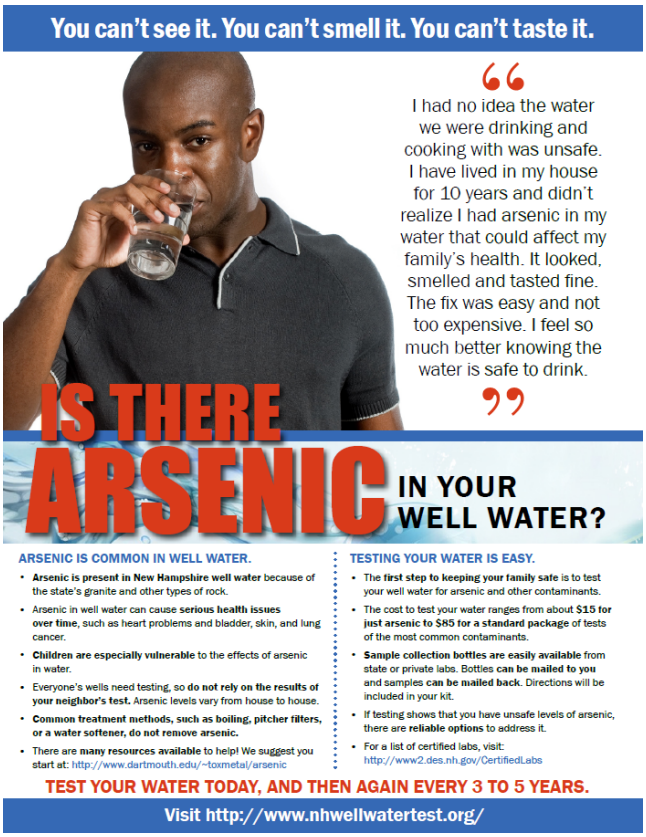
★ Drafts of favorite visual and message themes can be seen below.

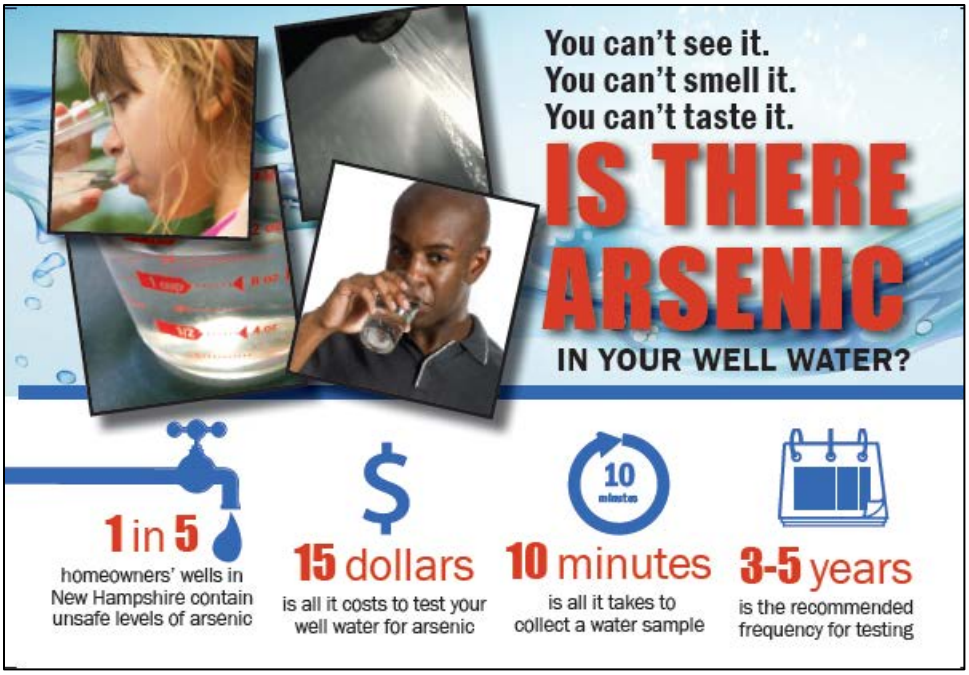


Finalization of Communication Materials

We utilized the resulting information from the market testing, including preferences regarding design elements, fonts and colors to design marketing pieces. The nature and structure of the pieces was informed by the needs of the community-based interventions. It was determined that a generic postcard design based on market testing would be the basis of the community-based promotion. Three versions of the market-tested postcard were created, which were then vetted by DTMSRP and NH DES staff for accuracy and appropriateness. Through a democratic process, a final version was chosen. The chosen postcard was made flexible by creating stickers for town specific events or to drive townspeople to the website to order a test kit. Flyers and posters were made as companion pieces to be hung in community spaces or handed out at community activities as well. PDFs were also made available for online dissemination or communication. Materials were distributed throughout the town to promote scheduled Testing Events. For Town Communication interventions, the versions of these basic materials that the town felt would be useful were provided and the town contact then disseminated those materials. For Intercept Campaigns, materials were handed out at the event to townspeople who were in the area. Copies of final products can be seen below:







ARSENIC IS COMMON IN WELL WATER.

- **Arsenic is present in New Hampshire well water** because of the state's granite and other types of rock.
- Arsenic in well water can cause **serious health issues over time**, such as heart problems and bladder, skin, and lung cancer.
- **Children are especially vulnerable** to the effects of arsenic in water.
- Everyone's wells need testing, so **do not rely on the results of your neighbor's test.** Arsenic levels vary from house to house.
- **Common treatment methods, such as boiling, pitcher filters, or a water softener, do not remove arsenic.**
- There are **many resources available** to help! We suggest you start at: http://www.dartmouth.edu/~toxmetal/arsenic

TESTING YOUR WATER IS EASY.

- The **first step to keeping your family safe** is to test your well water for arsenic and other contaminants.
- The cost to test your water ranges from about **$15 for just arsenic to $85 for a standard package** of tests of the most common contaminants.
- **Sample collection bottles are easily available** from state or private labs. Bottles **can be mailed to you** and samples **can be mailed back.** Directions will be included in your kit.
- If testing shows that you have unsafe levels of arsenic, there are **reliable options** to address it.
- For a list of certified labs, visit: http://www2.des.nh.gov/CertifiedLabs

TEST YOUR WATER TODAY, AND THEN AGAIN EVERY 3 TO 5 YEARS.

INTERVENTION PLANNING, IMPLEMENTATION AND EVALUATION

Intervention Planning Overview

During Year 1 of the grant, partners selected the three local level interventions to be implemented in Year 2. They were Intercept Campaigns, Town Communications and Testing Events. Intercept Campaigns were designed to intercept community members at community events or hotspots and educate the community member on the importance of well water testing and upkeep. Town Communications efforts focused on using town specific communication channels to promote newly designed educational materials. Testing Events were designed to distribute test kits to local residents at a specific community location.
The table below shows intervention assignment by town pairing.

Town	Town Communication	Intercept Campaign	Testing Event
Barrington	X		X
Bow	X		X
Londonderry		X	X
Windham		X	X
Pelham	X	X	
Epsom	X	X	

A great variety of partners helped to plan and implement interventions within each town. Each town had at least one engaged partner, while a few towns had 3-4 engaged partners. Involvement and commitment of partners varied greatly. Some partners engaged via email and phone while others volunteered at in-person events. Partners also changed as the process moved forward. Specific partners included:

- Community Development Directors
- Town Planners
- Town Administrators
- Current and former Select Board members
- Library directors
- Members of town environmental, conservation and water safety committees
- Town health officers
- Town administrative support staff

Evaluation Overview

Details of our evaluation plan, created by our subcontractor, the Community Health Institute, are included in the table below:

Interventions & Process Measures	
Town Communications	• # individuals exposed to each communication (e.g., # on listserv, # of articles, newspaper distribution)
Intercept Campaigns	• # attendees • # of people who take information
Testing Events	• # of attendees • # of people who take information

Intent to Test by Town by Intervention

- Request test kit through webpage*
- Request test kit by sending postcard to CHI*
- Request test kit by returning post card in person*
- Receive test kit in exchange for returning postcard in person**

*Requests received by CHI will be sent to the State Lab daily via spreadsheet. The State Lab will then send out the test kit, with the form on a colored paper.
**Individuals who receive a testing kit at an event will be given the form on a colored paper matching that of the lab.

Change in Testing Behavior

- Measured by the number of colored forms the State Lab receives back with test kits
  - From this, the proportion of individuals who have intent to test that actually get their water tested can be calculated
- Number of kits returned to the DHHS Public Health Laboratory as a direct result of our intervention from June-August 2015 compared to the baseline of number kits returned to the DHHS Public Health Laboratory for June - August 2014.

Process evaluation measures for each intervention were collected. For Town Communications, the estimated number of exposures to the towns' messages were collected, based on details provided by town partners and total number of materials provided for distribution. For Intercept Campaigns, the number of attendees at the event, the number of attendees who saw the booth, and the number of attendees who took information or engaged staff in a conversation about well water testing were collected. For Testing Events, the number of attendees at the event, the number of attendees who saw the booth, and the number of test kits distributed were collected. Intercept campaigns and testing event information was collected by DTMSRP and CHI staff on the day of the event and attendance estimates were provided by event organizers.

The number of test kit requests from each town was used to measure the intent to test. Test kits could be *requested* or picked up at Testing Events. Town Communications and Intercept Campaigns promoted two ways in which a test kit could be requested: by returning a pre-stamped postcard or by visiting a website. All requests via postcard or website were received by CHI and passed on to the DHHS Public Health Lab. The postcard and website mirrored the questions asked on NH DES' website to request a test kit (e.g., name, address, type of kit), with the addition of a few optional survey questions (e.g., prior testing history, motivation for testing).

Change in testing behavior by town was calculated in two ways. First of all, all test kits distributed at Testing Events or through requests to the DHHS Public Health Lab were given a color-coded form to be returned with the water samples. Through this process, the DHHS Public Health Lab was able to separate out test kits that resulted from an intervention associated with this project. The DHHS Public Health Lab provided information on the number of test kits returned as part of the project's interventions for each town. In addition, the DHHS Public Health Lab also provided 2014 and 2015 data on the number of test kits they received from each intervention town over the intervention period. The 2015 data was compared to the baseline 2014 data to determine the change in the total number of tests per town.

Results By Town

Barrington

Town Description

The town of Barrington is located in Strafford County, New Hampshire. The town is known for its natural beauty and its proximity to the seacoast. Barrington town government has a combination of elected and appointed officials/officers, including an elected Board of Selectmen. Barrington has a number of active community groups and town committees. According to the 2010 census Barrington has a total population of 8,576, with 3,154

households. Approximately 6,898 residents are served by private wells. Ninety-seven percent (97%) of the population identifies as being white. The town has a total area of 49 square miles.

Intervention Planning

The town of Barrington was selected to implement Town Communications and a Testing Event. Two key town staff helped to plan the interventions. For Town Communications town staff felt a postcard mailing to each resident would be most successful, as the town had success with similar mailings in the past. The original postcard design was edited to include the town seal and a label indicating that the event and postcard were grant funded, with support of town partners. In addition to the town-wide mailing, Barrington partners planned to post a PDF of the informational flyer on their town webpage and to post flyers around town. These flyers had general information and announced the Testing Event.

Town partners recommended the Testing Event be held on a weekend. The town transfer station was selected as the best location and staff at the station was willing to accommodate the event, allowing us to use the Highway Department side of the lot. The location is a regular weekend stop for many Barrington residents and it was hoped that traffic heading to local athletic fields nearby might also increase participation. There was an open garage to be used in case of rain. Town partners were interested in bringing refreshments, which was allowed at their expense and arrangement. At least one town staffer committed to staffing the event, which was scheduled to run from 8:00 a.m. – 4:00 p.m.

Intervention Implementation

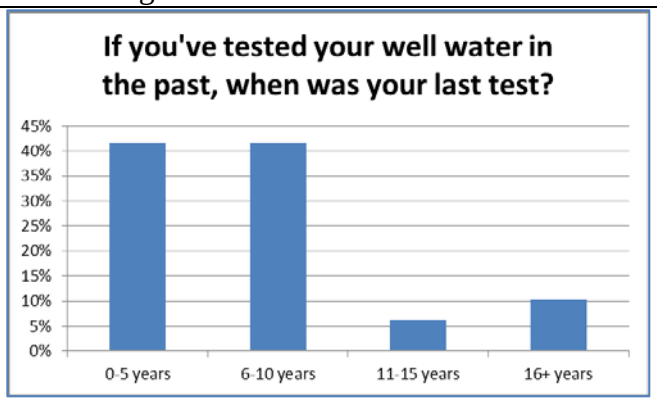
Implementation of Town Communication happened as planned. Efforts commenced 2-2.5 weeks before the Testing Event. A 4 x 11 inch postcard was mailed to each resident. 3,857 postcards were mailed in total. Additional postcards were given to town partners to be distributed if able. The PDF flyer was posted on the town website for 2.5 weeks and 10 8.5x11 inch flyers were posted in town government locations.

The Testing Event was held on Saturday July, 18th, from 8am-4pm at the Barrington Transfer Station. The weather was overcast, but it did not rain. Some attendees came, postcard in hand, to the location specifically to pick up a kit while others came to drop off trash at the station and noticed the event. In addition to our distribution table the town set up a refreshment table with coffee, donuts and popcorn. The event was staffed by two grant staffers in addition to one town staffer who volunteered all day, while another town staffer was onsite and helped as needed throughout the event. There was some confusion regarding the kits being returned to the lab by individuals vs. being returned to the lab in a group by our community partner. In keeping with the original grant design we did edit our messaging to make sure people returned the kits on their own, although some kits were collected by our community partner before messaging could be changed. Some residents recommended additional signage, as they had a

hard time locating the event. Lasting a total of eight hours, this was the longest in-person intervention held.

Intervention Evaluation Table:

Barrington		**Town Communications**	**Testing Event**
Date		6/29/15 - 7/20/15	7/18/15
Process Measures	Exposure	• Postcards mailed to 3,857 households and businesses (100% of addresses in town) • Flyer on town website for 2.5 weeks • 10 flyers around town	~120 attendees
	Engagement	16 test kits requested	103 test kits distributed
	Households Engaged	0.5%	3.3%
Intent to Test	# of test kit requests	119	
	% of households	3.8%	
Change in Testing Behavior	Test kits returned	25 (21.0% of those that received a test kit; 0.8% of households)	
	Change in tests (baseline 2014)	600% increase (2015: 28; 2014: 4) # of kits returned to the DHHS Public Health Lab from June-August 2015 compared to the baseline of # kits returned to the DHHS Lab for June - August 2014.	



(These graphs were created using information collected via a questionnaire completed when community members ordered or picked up a well water test kit)

Bow

Town Description

The town of Bow is located in Merrimack County, New Hampshire. The central New Hampshire town is five miles from the state capital, Concord. Bow's proximity to two major interstates makes it easily accessible to visitors and links residents to the larger state. Bow town government has a combination of elected and appointed officials/officers, including an elected Board of Selectmen. The town has many active community organizations and numerous recreational activities. According to the 2010 census Bow has a total population of 7,519, with 2,717 households. Approximately 7,043 residents are served by wells. 97% of the population identifies as being white. The town has a total area of 28 miles.

Bow is fortunate to have a Drinking Water Protection Committee. The committee was formed in 2005. The original purpose of the committee was to help develop source water protection plans for municipal facilities. The committee has recognized the need to protect water quality and over the last five years has worked to educate the community on the importance of private well testing. Starting in July of 2014 The Bow Drinking Water Protection Committee conducted a groundwater/private wells study in an area of town where residents complained about plumbing corrosion issues. A survey was sent to approximately 150 homeowners requesting information about their well, interior plumbing and treatment utilized. The survey also requested permission to sample the homeowners well at no cost to the homeowner. Approximately 80 homeowners granted permission to have their well sampled. The wells were sampled and the results were sent to the homeowner with interpretive guidance and recommendations. This work was done in partnership with NH DES.

Intervention Planning

The town of Bow was selected to implement Town Communications and a Testing Event. One town staff person and two volunteer members of the town Drinking Water Protection Committee were very active in the planning, and consulted with the full committee for suggestions before implementation started. For Town Communications the planning team selected the posting of a PDF flyer on the town website and posting flyers at town locations. Both these selections were implemented 2-2.5 weeks before the Testing Event. The team also planned to promote the event through other channels as able.

Town partners in Bow felt it was very important that the Testing Event take place before the end of the school year, before local residents left for summer vacations and travel. This meant selecting a Saturday in early June to mid-June. The Bow Community Building was selected as the event location. The building is conveniently located on a main thoroughfare in Bow, has ample parking and potential for use of their external sign. Five members of the Bow Drinking

Water Protection Committee volunteered to staff the event. The committee was interested in additional promotion of the event, outside of formal Town Communication efforts. This work was done outside of the grant design and organized by members of the committee. This was not considered Town Communication, as grant specific communication materials were not used, the material was not delivered through town channels and did not include educational content.

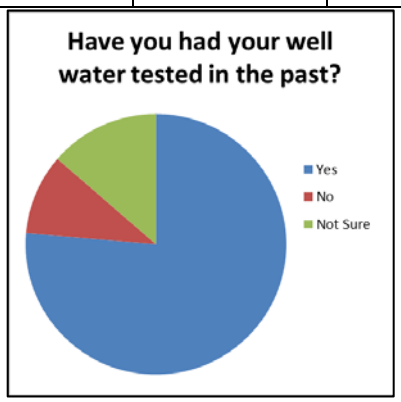
Intervention Implementation

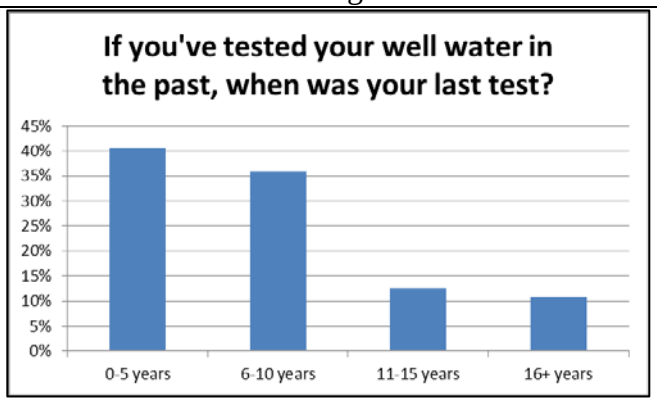
Implementation of Town Communications went as planned. A PDF of the flyer was posted on the town website from June 6th to June 20th. Print copies of the flyer were posted at town government locations and area businesses starting on June 3rd and ending on June 10th. It is unclear how long the posters hung at each location. The Bow Drinking Water Protection Committee promoted event details through a number of different channels in the two weeks before the event. This included announcing event details on local outdoor signs, running block advertisements in local papers and in local e-newsletters. While this was not formal town communication it likely had an impact on event turnout.

The Bow Testing Event was held on Saturday, June 20, from 8:00 a.m. – 2:00 p.m. at the Bow Community Building. The weather was sunny and warm. The distribution table was set up outside of the building and could easily be seen by passing traffic. There was a large sign outside of the building announcing the event, decorated by the Bow committee with colorful balloons. There was ample parking next to the building, making it very accessible to vehicle traffic. In addition to the two grant staffers, five members of the Bow Drinking Water Protection Committee volunteered their time as did an intern from NH DES. The committee also provided radon water test kits for Bow residents; radon in air and water above recommended action levels is quite common in Bow, and many homes have radon-in-air mitigation and/or radon-in-water treatment systems. Radon kit distribution was not captured in our grant reporting. Turnout was high and steady throughout the six hour event. We brought 50 arsenic only test kits and 50 standard analysis test kits to be distributed. This estimate was based on other test kit distribution events held in Bow where no more than 30 kits had been distributed. By 10:00 a.m. we had completely run out of the 50 standard test kits we had brought. We then took paper orders for kits, apologizing to visitors and telling them to expect the kits in the mail. Serendipitously a staffer from the DHHS Public Health Lab happened to stop by the event and upon hearing about the situation went to the lab to gather components for additional kits. By 11:30 a.m. the team had made 50 additional standard analysis kits to be distributed and we stopped taking paper orders.

Intervention Evaluation Table

Bow		**Town Communications**	**Testing Event**
Date		6/1/2015 - 6/20/15	6/20/15
Process Measures	Exposure	• Flyer on website, in town offices, and around town • Local newspapers	~120 attendees
	Engagement	1 test kit distributed	114 test kits requested
	Households Engaged	0.04%	4.2%
Intent to Test	# of test kit requests	115	
	% of households	4.2%	
Change in Testing Behavior	Test kits returned	15 (13.0% of those that received a test kit; 0.6% of households)	
	Change in tests (baseline 2014)	72.2% increase (2015: 31; 2014: 18) # of kits returned to the DHHS Public Health Lab from June-August 2015 compared to the baseline of # kits returned to the DHHS Public Health Lab from June - August 2014.	





(These graphs were created using information collected via a questionnaire completed when community members ordered or picked up a well water test kit)

Epsom

Town Description

The town of Epsom is located in Merrimack County, New Hampshire. Epsom offers a combination of rural landscape with some village amenities. The town itself is six miles by four miles. Epsom town government has a combination of elected and appointed officials/officers, including an elected Board of Selectmen. Epsom has a number of active community groups and

town committees. According to the 2010 census Epsom has a total population of 4,566, with 1,708 households. Approximately 3,101 residents are served by private wells. According to the 2000 Census 99% of the population identifies as being white.

Intervention Planning

The town of Epsom was selected to implement Town Communications and Intercept Campaigns. A current and former elected town official helped with planning as able. For town communications, partners selected distributing informational postcards in town offices and posted a PDF of the informational flyer on the town website.

Planning two Intercept Campaigns in Epsom proved challenging. There were a limited number of community events taking place during our mid-May- end of July implementation window and a lack of a community hub made identifying a popular community "hotspot" a challenge. With the help of partners we were able to connect to the Epsom Library. Having discussed a variety of dates with the librarian it seemed most days were equally busy. We selected a weekday, mid-afternoon–early evening in an attempt to reach individuals coming home from work. After continued discussion we selected Epsom Old Home Days for the second event. We had originally rejected this event, as it fell outside of our implementation period, but given the limited choices within Epsom we felt we needed to expand our window to include this early August event.

Intervention Implementation

Town Communication implementation happened as planned. The informational flyer was posted on the town webpage in mid-June (for an unspecified amount of time). In June a town partner was sent 200 informational postcards to be distributed at various town offices.

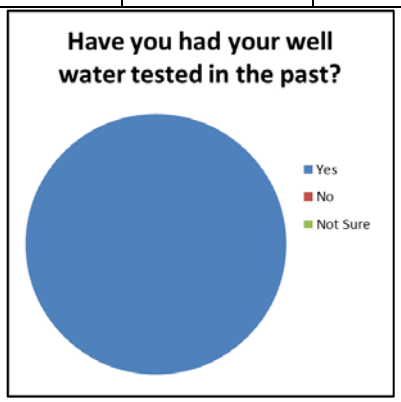
The first of two Epsom Intercept Campaigns took place at the Epsom Public Library on Monday, July 13th from 2:00 p.m.- 6:00 p.m. Turn out for the event was light, with approximately 20 people visiting the library while we were there, seven of whom engaged in conversation regarding the display. We set up our informational display directly inside the library doors across from the circulation desk. Any person entering the library saw our display. At the start of the event we had two grant staffers, but given the very light turn out one staffer left at 4:00p.m. Event details were announced in the July issue of the library e-newsletter.

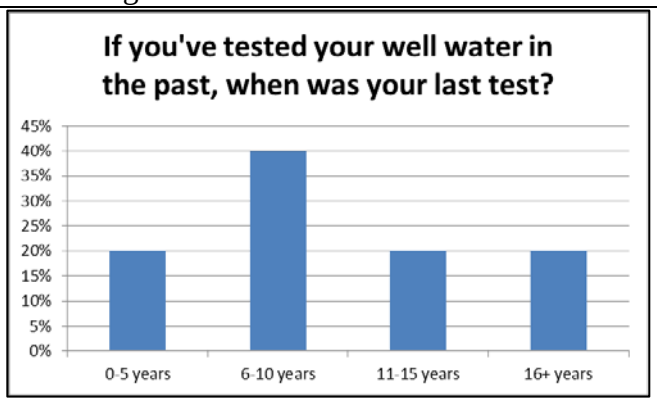
The second of the two Epsom Intercept Campaigns took place during Epsom Old Home Day on Saturday, August 8th, from 8:30 a.m. to 4.30 p.m. The town-wide event was held in Webster Park. The event featured approximately 15 booths, a morning car parade, food vendors and special events throughout the day. The booths were a combination of informational booths, retailers and community businesses. Our informational booth was the last in the lineup of 15.

The weather was very warm and sunny. During the first four hours of the event our booth was staffed by two grant staff, while the last four hours had one staffer. Approximately 250-350 people attended the event in total, with around 75 visiting our booth. Within the first hour three elected Epsom representatives visited our tent. Both attendees and organizers of the event commented that attendance was lower than the previous year.

Intervention Evaluation Table:

Epsom		**Town Communications**	**Library Intercept Campaign**	**Old Home Days Intercept Campaign**
Date		6/15/15	7/13/15	8/8/15
Process Measures	Exposure	• Postcards in town offices • Flyer posted on webpage	~20 attendees	~75 attendees
	Engagement	Unknown	~7 attendees	~30 attendees
	Households Engaged	Unknown	0.4%	1.7%
Intent to Test	# of test kit requests	6		
	% of households	0.3%		
Change in Testing Behavior	Test kits returned	1 (16.7% of those that received a test kit; 0.06% of households)		
	Change in tests (baseline 2014)	No change (2015: 5; 2014: 5) # of kits returned to the DHHS Public Health Lab from June-August 2015 compared to the baseline of # kits returned to the DHHS Public Health Lab for June - August 2014.		





(These graphs were created using information collected via a questionnaire completed when community members ordered or picked up a well water test kit)

Londonderry

Town Description

The town of Londonderry is located in Rockingham County, New Hampshire. Londonderry, in conjunction with Manchester, is home to the Manchester-Boston Regional Airport. Londonderry town government is built around the elected Town Council. According to the 2010 census the population of Londonderry is 24,129, with 8,496 households. A section of Londonderry has been designated a Census-Designated Place (CDP) by the 2010 census. This designation signifies a large population cluster. Approximately 11,037 people reside within the Londonderry CDP. Geographically this area is located within the southern region of Londonderry. Approximately 15,542 residents are served by private wells. 96% of the population identifies as being white. The town has a total area of 42 miles.

Intervention Planning

The town of Londonderry was selected to implement Intercept Campaigns and a Testing Event. Community partners and town staff were extremely helpful and involved in helping to plan these events. The two Intercept Campaigns took place before the Testing Event. The first Intercept Campaign scheduled was the Londonderry Lions Club Community Yard sale. In the past this event has drawn 200-300 people according to organizers. A community partner suggested an event be held at the local supermarket but their corporate office did not respond to requests in a timely manner. The second event was scheduled to take place at the Town Drop-Off Center. Staffers at the location were willing to help with set up and local residents frequently visit on Saturdays.

Our town partner was more than happy to host the Testing Event at the Town Hall, where town offices are located. It was recommended that we schedule it at the beginning or the end of the month, when more residents would be coming in to register their vehicles. Town hall is closed on weekends, making a weekday event a necessity. Setting up outside would also allow residents visiting the library to see the table also and possibly stop.

Intervention Implementation

The first Intercept Campaign was held on Saturday, May 16, at the Lions Club Yard Sale in the Lions Hall parking lot on Mammoth Road, from 7:30 a.m. – 12:30 p.m. This was the first event implemented all summer. The weather was unseasonably cold and there was a light drizzle during most of the event. We set up our table among the yard sale participants. Attendance was constant throughout the morning, despite the poor weather. Two grant staff manned the table. After one hour we decided we needed a “give away” at our table and one staffer went to a local store to purchase granola bars as a giveaway. While we did speak to approximately 35

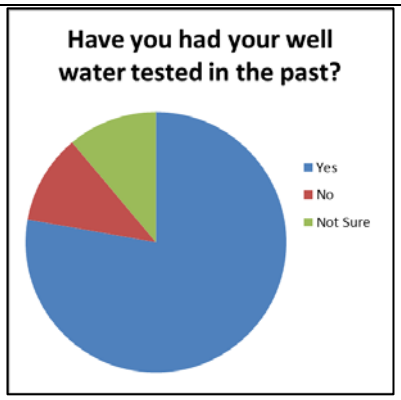
people at least half reported using town water, not private well water. This is likely a result of Londonderry being so large and having a mixture of town and private well water.

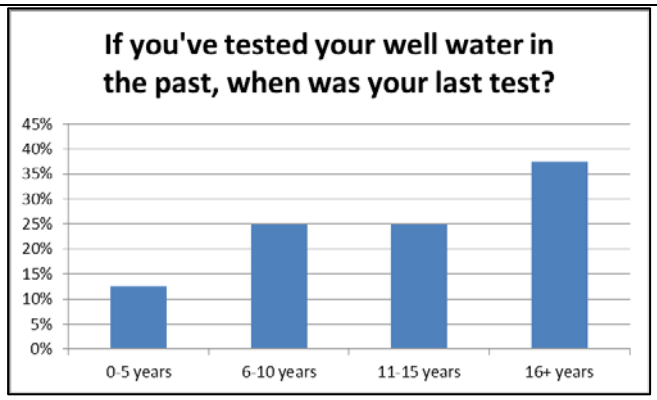
The second Intercept Campaign was held on Saturday, July 11th at the Town Drop-Off Station from 9:00 a.m. – 2:00 p.m. The weather was very warm and sunny. This event was staffed by one staffer. We originally set up the display near the exit but no one stopped for the first hour. The table was then relocated to just outside the station entrance. Cars were often backed up at this location, waiting to speak to the attendant, giving grant staff time to pass out information though car windows. This did limit the ability for attendees to read the display completely. Upon leaving the event it was discovered there was a serious car accident on the road leading into the station and the road was closed as a result. This may have affected overall attendance.

The Londonderry Testing Event took place on Friday, July 24th, from 10 a.m. – 4 p.m. at the Town Hall. The distribution table was set up outside near the most frequented entrance and could be seen from the parking lot. Later the table was moved inside due to rainy weather. The event was staffed by two grant staffers, with logistical help from a town partner. While the town did some promotion of the event beforehand most participants had come to the town hall for another purpose and ended up picking up a kit as a matter of convenience.

Intervention Evaluation Table

Londonderry		**Yard Sale Intercept Campaign**	**Town Drop Off Intercept Campaign**	**Testing Event**
Date		5/16/15	7/11/15	7/24/15
Process Measures	Exposure	~75 attendees	77 attendees	~50 attendees
	Engagement	~35 attendees	19 attendees	19 test kits distributed
	Households Engaged	0.6%	0.3%	0.3%
Intent to Test	# of test kit requests	19		
	% of households	0.3%		
Change in Testing Behavior	Test kits returned	1 (5.3% of those that received a test kit; 0.06% of households)		
	Change in tests (baseline 2014)	33.3% decrease (2015: 2; 2014: 3) # of kits returned to the DHHS Public Health Lab from June-August 2015 compared to the baseline of # kits returned to the DHHS Public Health Lab for June - August 2014.		





(These graphs were created using information collected via a questionnaire completed when community members ordered or picked up a well water test kit)

Pelham

Town Description

The town of Pelham is located in Hillsboro County, New Hampshire. Pelham is flanked by the cities of Nashua and Salem, and shares its southern border with Massachusetts. Pelham town government is built around a board of selectmen. The town has many active community organizations and numerous recreational activities. According to the 2010 census Pelham has a population of 12,897, with 4,357 total households. 96% of the population identifies as being white. The town has a total area of 27 miles. Approximately 15,542 residents are served by private wells.

Intervention Planning

The town of Pelham was selected to implement Town Communications and Intercept Campaigns. A current town employee helped select town communication methods and with the planning of in-person events. Other community partners suggested potential locations for in-person events also. After our town partner reviewed our communication materials it was decided that a combination of postcard distribution at town offices and a posting of the flyer on the town webpage would work best for the town.

After requesting and being denied permission to set up an information table at a few different town locations we had success with the Pelham Library and at the Pelham Plaza in front of the bank. The library was very flexible with scheduling. To increase potential attendance, we decided to set up our intervention in conjunction with another library event. We also selected a late afternoon to early evening timeframe in the hopes of reaching individuals returning from work. The second Intercept Campaign was scheduled to take place at Pelham Plaza, an outdoor strip mall with a number of businesses clustered around a Hannaford grocery store. Setting up

logistics for this event took coordination and effort by four different individuals. It was finally agreed we could set up in front of a local bank in the plaza. We selected a weekday, since most weekends were already booked with other events.

Intervention Implementation

Town Communication implementation happened as planned. The informational flyer was posted on the town webpage for the month of August. This was outside of the original implementation timeline but data collection methods continued until the end of August so this later posting was captured in the results. In early July a town partner was sent 500 informational postcards to be distributed at various town offices including, the planning office, the Town Clerk's office, the board of selectman's office, the Town Hall Lobby coffee table, the library, the Police Station and the Fire Stations. As of the end of August approximately 150 had been distributed to the public. The rest remain on display.

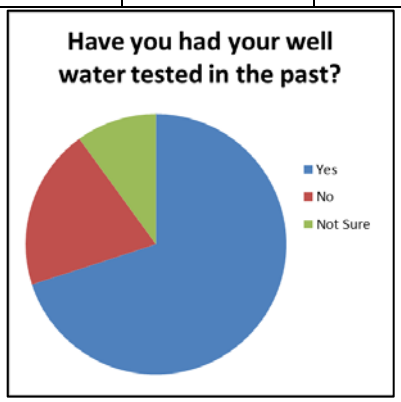
The first Intercept Campaign was held at the Pelham Library on Tuesday, June 2nd, from 4:30 p.m. - 8:00 p.m. This time was selected to overlap with an educational lecture taking place at the library. The informational table was set up inside the library in a prime location that allowed engagement with most people coming into the library. The event was staffed by two grant staff. Turnout was light and library staff noted that they thought more people would be attending the evening lecture. The library announced the event on their external sign.

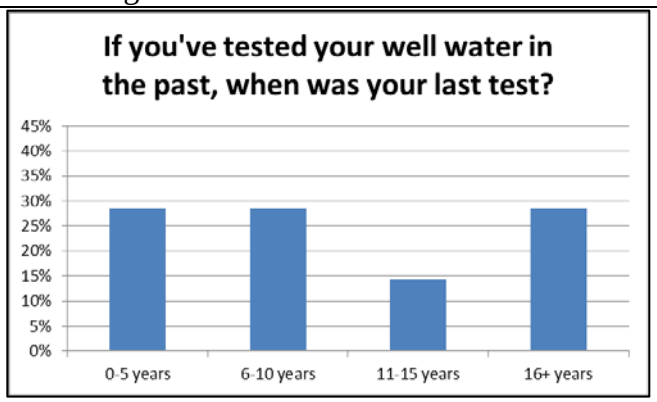
The second Intercept Campaign was held at Pelham Plaza on Tuesday, July 7th, from 10:00 a.m. – 4:00 p.m. We were given permission by the property owner to set up our table outside of Santander bank. This location was near the center of the strip of businesses, which helped us reach the greatest number of people. It was very warm and sunny, with thunderstorms in the afternoon. These storms blew over the display several times and as a result we ended the event 30 minutes early. The event was staffed by two grant staff. We had a consistent flow of individuals throughout the day.

Intervention Evaluation

Pelham		**Library Intercept Campaign**	**Pelham Plaza Intercept Campaign**	**Town Communications**
Date		6/2/15	7/7/15	7/13/15 – 8/31/15
Process Measures	Exposure	13+ attendees	~75 attendees	• Flyer on website • Postcards at town offices
	Engagement	9 attendees	22 attendees	
	Households Engaged	0.2%	0.5%	
Intent to	# of test kit	10		

Test	requests	
	% of households	0.2%
Change in Testing Behavior	Test kits returned	0
	Change in tests (baseline 2014)	80.0% decrease (2015: 1; 2014: 5) # of kits returned to the DHHS Public Health Lab from June-August 2015 compared to the baseline of # kits returned to the DHHS Public Health Lab for June - August 2014.





(These graphs were created using information collected via a questionnaire completed when community members ordered or picked up a well water test kit)

Windham

Town Description

The town of Windham is located in Rockingham County, New Hampshire. Windham offers a combination of rural landscape mixed with some suburban sections. Windham town government is built around a Board of Selectmen, with additional town governance work being completed by a Town Administrator and other town staff. The town has many active community organizations and numerous recreational activities. According to the 2010 census Windham has a population of 13,592, with 4,887 total households. 95% of the population identifies as being white. The town has a total area of 27 miles. Approximately 10,463 residents are served by private wells.

Intervention Planning

The town of Windham was selected for Intercept Campaigns and a Testing Event. A current town employee helped with planning and the securing of locations for all three events. A variety of community events were considered during planning, including the “adopt a spot” kickoff event, the community garden event, and an electronics recycling event. Other common

community locations considered included: the transfer station, the town beach, town offices and the library. We decided to select one special community event and one community hotspot for our two intercept campaigns, hoping to reach individuals interested in the special event and the public at large. For the Testing Event we selected the town offices, thinking this would provide a balance of regular foot traffic and would be easy to locate by individuals coming with the express purpose of picking up a kit. Scheduling at town offices was easily accomplished as our town partner was an employee.

Intervention Implementation

The first Intercept Campaign was held on Saturday June 6th, from 8:00 a.m. – 12:00 p.m. at the Windham Community Day, Crossing Life Church on North Lowell Road. In addition to our information table there was a small car show, a kick-off event for the community garden, and later in the afternoon, live music and a barbecue. We set up outside in warm, sunny conditions. The event was staffed by two grant staff, and our town partner was onsite to help with logistics as needed. Turnout was light and it was noted by other participants that more attendees and vendors had been expected. After the event, informational flyers were posted at the church onsite, the childcare center across the street and at a café down the road.

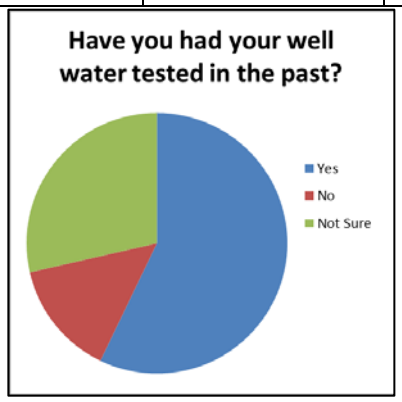
The second Intercept Campaign was held on Saturday, June 13th, from 9:00a.m.-2:00 p.m. at the Nesmith Library in Windham. We set up our informational table just inside the front entrance. The table was manned by two grant staff. Turnout was fair although library staff felt library attendance was lower than normal for a Saturday.

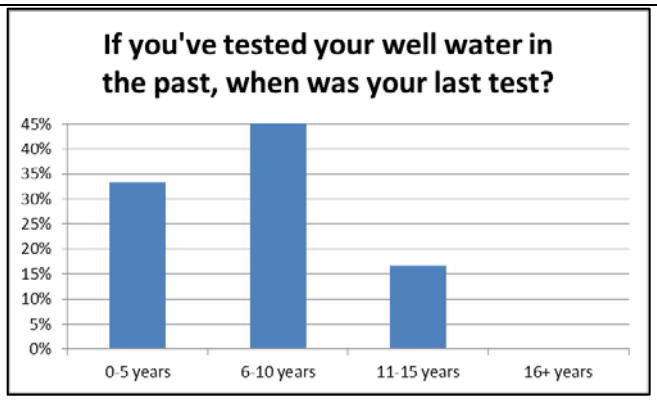
The Testing Event was held on Thursday, June 25th from 2:00 p.m. – 6:00 p.m. at the Community Development Office in Windham. Our town partner announced the event in various local publications and an interview focusing on the importance of well water testing was published in The Union Leader on June 23rd. Unfortunately, the article listed the incorrect date for the Testing Event. We set up our distribution table within the large conference room, off a small hallway. The event was staffed by two grant staff for the first two hours, and one grant staffer for the last two hours. In addition to our distribution event an NH DES staffer and intern shared the space and interviewed attendee's reaction to the *Be Well Informed* computer application. Our town partner was onsite for support and any logistical needs. Turnout was light to medium.

Intervention Evaluation Table:

Windham	**Community Day Intercept Campaign**	**Library Intercept Campaign**	**Testing Event**
Date	6/6/15	6/13/15	6/25/15

Process Measures	Exposure	14 attendees	65 attendees	~20 attendees
	Engagement	14 attendees	13 attendees	17 test kits distributed
	Households Engaged	0.3%	0.3%	0.4%
Intent to Test	# of test kit requests	21		
	% of households	0.4%		
Change in Testing Behavior	Test kits returned	3 (9.7% of those that received a test kit; 0.06% of households)		
	Change in tests (baseline 2014)	200% increase (2015: 6; 2014: 2) # of kits returned to the DHHS Public Health Lab from June-August 2015 compared to the baseline of # kits returned to the DHHS Public Health Lab for June - August 2014.		





(These graphs were created using information collected via a questionnaire completed when community members ordered or picked up a well water test kit)

Summary Evaluation Table

All Towns		**Testing Event**	**Intercept Campaigns**	**Town Communications**
Process Measures	Exposure	310 attendees	414 attendees	Messaging in 4 towns
	Engagement	253 test kits distributed	149 attendees; ~13 test kits requested	~18 test kits requested
	Test Kit Requests	1.1%	0.06%	0.08%
Intent to Test	# of test kit	290		

	requests	
	% of households	1.3%
Change in Testing Behavior	Test kits returned	45 (15.5% of those that received a test kit; 0.2% of households)
	Change in tests (baseline 2014)	97.3% increase (2015: 73; 2014: 37) # of kits returned to the DHHS Public Health Lab from June-August 2015 compared to the baseline of # kits returned to the DHHS Public Health Lab for June – August 2014.
Total number of hits on the Test Kit Ordering Landing Page	406	

Intervention Implementation Evaluation Limitations

Several evaluation limitations presented themselves during the implementation and evaluation of the interventions. First of all, there were differences in interventions that could not be controlled for. For example, some Bow Testing Event attendees had to be mailed test kits due to the overwhelming attendance at the event. This may have affected the change in testing behavior measure for Bow, as the Testing Event was more similar to an Intercept Campaign for those attendees that did not receive their test kits immediately. In addition, Testing Event attendees were required to return their test samples in person or by overnight mail to the DHHS Public Health Lab if they wanted a bacterial analysis to be done. One testing event was held in a neighboring town (Bow), but the other three were in towns which are a 35-40 minute drive from Concord. In addition, at the Barrington Testing Event (one of the towns that is further from Concord), a town employee offered to gather and return test kits together for some of the residents during the first half of the Testing Event. The barrier to returning the test kits therefore differed depending on the town.

Secondly, the data collection timeframe was fairly short and some who received a test kit through an intervention may still return their samples, but cannot be counted within this evaluation. However, this limitation would lead to an underestimation of the impact of the interventions, so the results can be considered conservative.

Thirdly, the audience for many Town Communication efforts could not be quantified. For example, towns hung flyers in public places, but the number of individuals who saw the flyers cannot be estimated.

Finally, all of the interventions directed testing to the DHHS Public Health Lab for ease of data collection. However, it is possible that the promotion of the interventions also led to an

increase in testing through local private testing companies in the intervention communities, but any change in the number of tests performed by private companies could not be assessed. This limitation may have led to an underestimation of the impact of the interventions.

Evaluation of Intervention Effectiveness

Statistically evaluating our interventions requires comparing our measures of effectiveness across "treatments" (pairs of towns with the same interventions), as well as against baseline (non-intervention) values.

For the baseline, data were obtained from the DHHS Public Health Lab on the number of tests performed in our six towns during the period June - August, 2014 (a year prior to our interventions). These data confirm what was found in our Year 1 survey: residents of towns with a greater probability of high (>10 ppb) well water arsenic levels (as estimated by the USGS) tend to test their water at a greater rate (R^2=0.66, Figure 8).

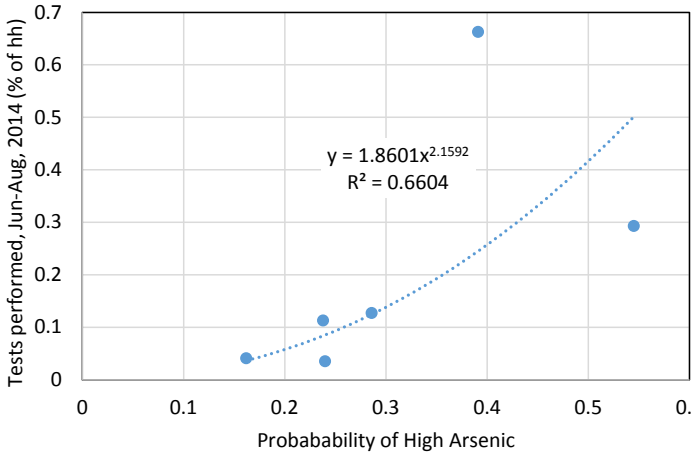


Figure 8. Plot of the number of tests performed in June-August of 2014 (expressed in terms of % of households) against the USGS estimated probability of well water arsenic levels greater than 10 ppb.

Comparable data for June-August, 2015 (the months during and following our interventions), show that the rates of testing across towns relate much less strongly to the probability of high

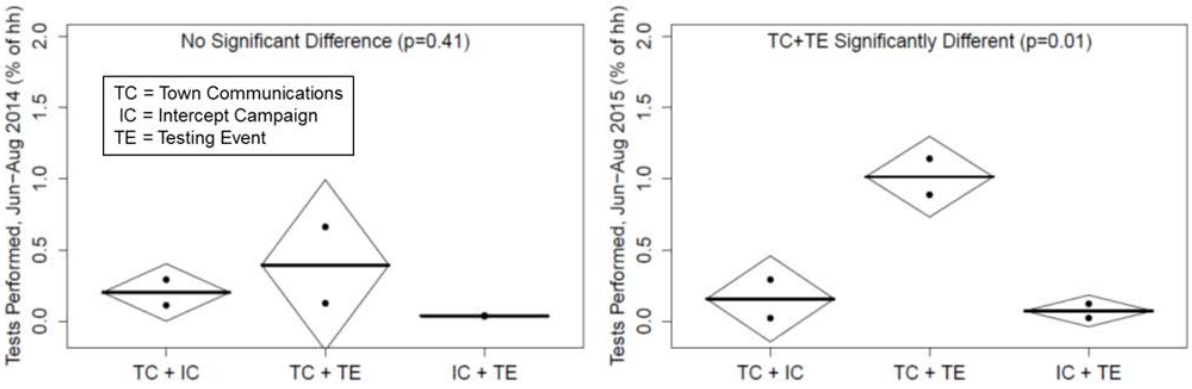


Figure 9: Diamond plots comparing the testing rate (% of households) across the pairs of towns chosen for our different interventions. Dots indicate testing rates in each town, bold horizontal lines indicate the median for each treatment, and diamonds represent the upper and lower limits of the 95% confidence intervals on the medians. If the diamonds of two treatments do not vertically overlap, this is "strong visual evidence" that the corresponding two medians significantly differ.

arsenic levels (R^2=0.26, figure not shown) and much more strongly to our pattern of interventions. In fact, in 2014 there was no significant difference in the testing rate between the pairs of towns chosen for our different interventions (p=0.41, Figure 9, left), while in 2015, these differences were significant (p=0.01, Figure 9, right). As can be seen in the right panel of Figure 9, the treatment consisting of the Town Communications (TC) and Testing Event (TE) interventions is associated with a significantly greater testing rate than the other two treatments.

Comparing the year-over-year difference in testing rate for each town yields an estimate of the increase in testing rate associated with our interventions. Results show that only the combination of Town Communications and Testing Event resulted in a significant increase in the testing rate, with 0.62% being the best estimate of this increase (Figure 10). Thus we can conclude that Testing Events were effective at increasing testing when preceded by Town Communications, but not when preceded by an Intercept Campaign (IC). Additionally, the combination of Town Communications and Intercept Campaign alone were not effective in significantly increasing testing. Of course, there is also the possibility that additional factors that happened to correspond with our interventions are responsible for the observed differences. Such "confounders" could include the ease of accessing the Testing Event sites, the weather or other activities on the day of the interventions, or enthusiasm of town partners in advertising or implementing the interventions. Nevertheless, based on the results of a follow-up survey described below, it does seem that most Testing Event participants from Bow and Barrington recall receiving a Town Communication, while participants in Testing Events in Londonderry and Windham primarily cite a previous event or table as their source of information about the

event. This is consistent with the types of interventions we implemented in these towns in advance of the Testing Events.

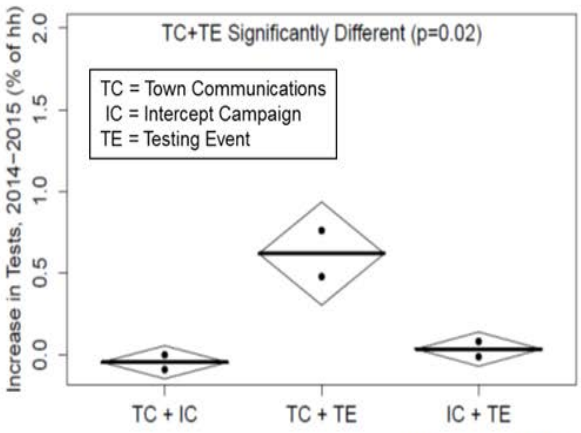


Figure 10: Diamond plots comparing the year-over-year increase in testing rate across the pairs of towns subject to our different interventions. Symbols have the same interpretation as those in the previous figure.

Results of the Well Water Test Kit Request Questionnaire

Every individual picking up or ordering a well water test kit was asked to complete a 5 question survey. The questions matched or were adapted from questions in the Year 1 survey. The questions included:

How did you hear about us?

- Event or information table in my town
- Mail, email, or other written notice
- Other

Why did you request a well water testing kit today?

- I received new information on the potential health risk of contaminates in well water
- I have been meaning to test and was reminded to do so.
- I learned it was less expensive than I expected.
- I received new information on the importance of testing well water regularly
- I was influenced by a friend, family member or other acquaintance.
- Other: _____

Have you tested your water in the past?

- Yes
- No
- Not Sure
    - If yes, when was your last test?
    - Did that test include arsenic?

If no, or not in the last 5 years, why haven't you had your water tested?

- I wasn't aware that I should.
- I did not know what to test for.
- I didn't know how to go about having it tested.
- I didn't think I would know how to act on test results.
- My water was tested before I moved in.
- I meant to have it tested but never got around to it.
- I have not had any health problems cause by drinking the water.
- My water looks, smells and tastes clean.
- I already have a water filter or treatment system.
- Other:_____

Over 230 individuals answered at least one of these questions when picking up a test kit at a Testing Event. An additional 35 answered at least one of these questions when requesting a test kit online. Results for individuals who picked up a kit at a Testing Event can be seen in Figures 11 and 12.

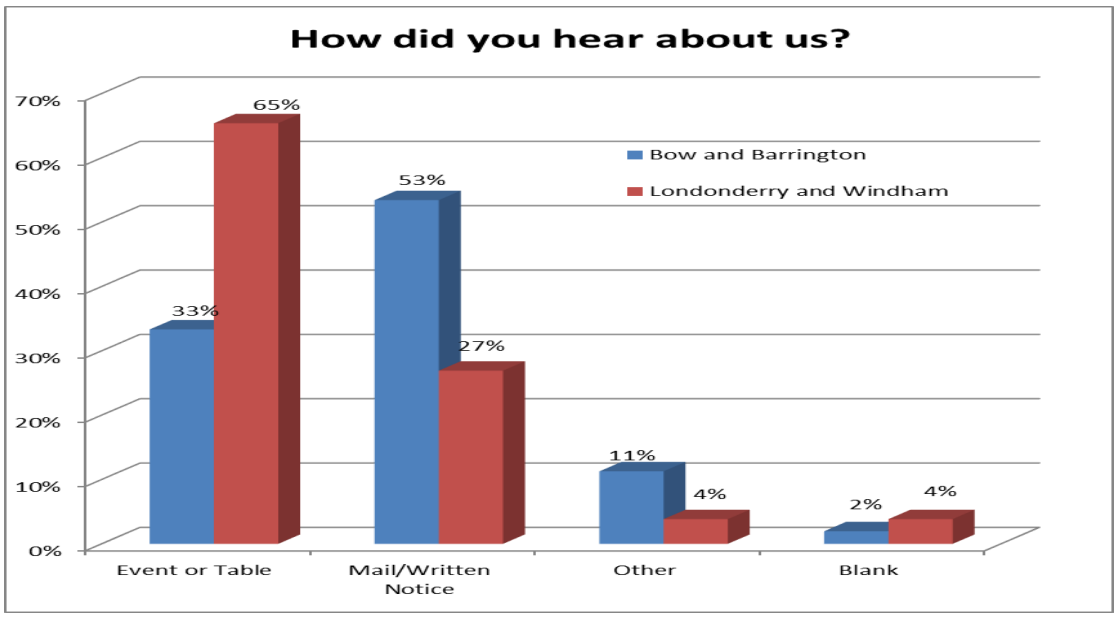


Figure 11. Comparison of survey responses by town based on potential answers.

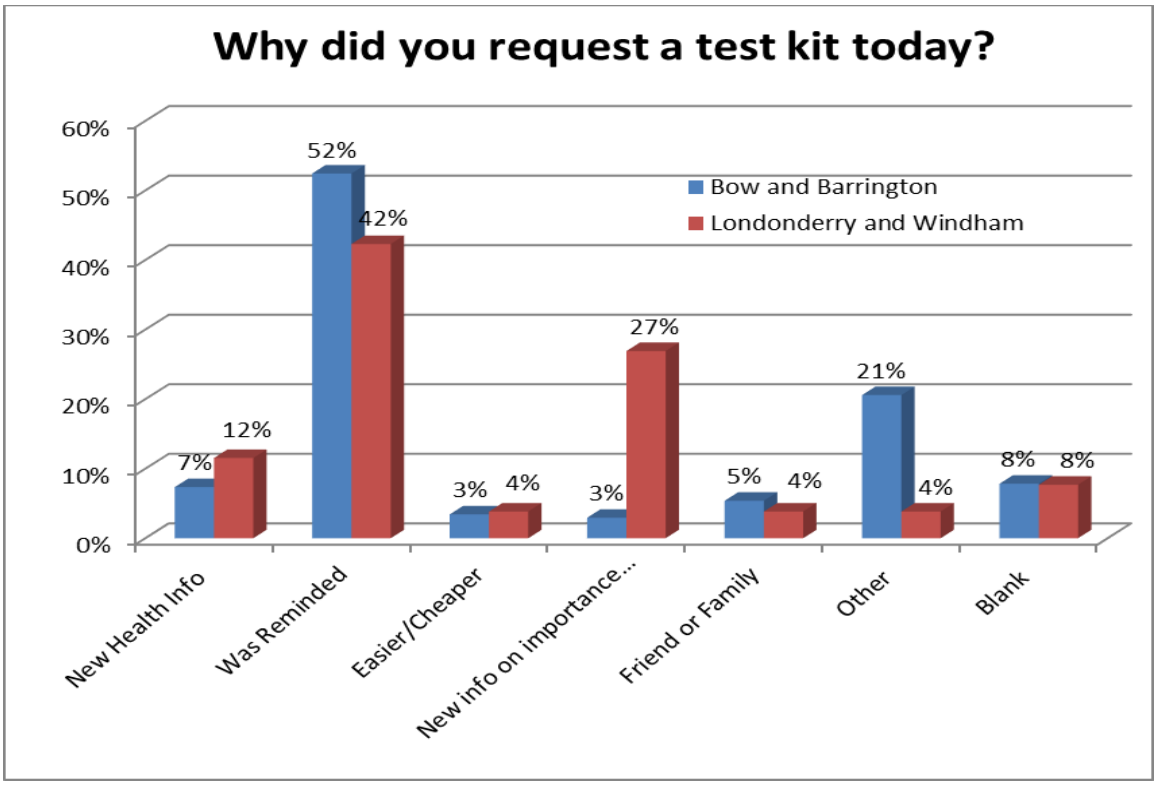


Figure 12. Comparison of survey responses by town based on potential answers.

COMMUNITY TOOLKIT

Purpose

Utilizing best practices identified through this grant, a Well Water Community Action Toolkit was created. While the grant focused on the implementation of three local level interventions, clearly the combination of Town Communication and Testing Events led to increased kit distribution and return. The toolkit is designed to help communities and individuals at any stage of readiness to start or enhance efforts to address community well water issues. A community or individual may choose to start the process at step 1 or they may select a step that meets their current needs of community engagement.

On September 14, 2015 the toolkit outline was reviewed by our Project Advisory Committee. This committee is composed of content and community engagement experts from around NH and the U.S. Members were very excited about the creation of the kit. A local partner was particularly excited by the opportunity to use vetted communication materials. The committee made numerous suggestions regarding distribution and promotion of the kit. On September 30, 2015 the toolkit was reviewed by our Technical Advisory Committee. Their comments have been incorporated into the final product.

Members of both groups felt the creation of the toolkit will give partners a much needed structure to continue to move forward with their efforts while expanding the reach of this grant into the future.

Design

The toolkit has three distinct sections as well as an appendix.

Section 1: Introduction

- Why use this toolkit?
- What is an intervention?
- Understanding Contamination in Private Well Water in NH
- A Comprehensive Approach
- Where to Start?

Section 2: Creating a Plan That Works for You and Your Community

- *Step 1*
    - **Community Assessment**- What is already happening in your town?
- *Step 2*
    - **Capacity Building**- Who is already involved and who should be involved
- *Step 3*
    - **Planning**
        - Identifying your general goal
        - Identify your audience
        - Select your intervention
        - Choose a specific success measure
        - Identifying your timeline
        - Setting up logistics
- *Step 4*
    - **Implementation**
- *Step 5*
    - **Monitoring**
        - Tracking your efforts
        - Reflection on the whole process

Section 3: Additional Resources and Local Experts

- Web links
- State Partners

Appendices:

Appendix A

Sample Interventions

- Town Communications
    - Sample/Free PDF's here
- Well Water Test Kit Events

Appendix B

What works in NH?

- A look at community efforts in Bow and Tuftonboro

Appendix C

Sample Worksheets

- Assessment of Current or Past Efforts
- Capacity Building
- Planning
- Implementation
- Tracking and Reflection

Distribution

The original purpose of the kit was to provide our six intervention communities with follow up tools and resources to continue their work. We have expanded the purpose to include any community interested in addressing this issue and communities interested in the more broad topic of general private well water testing. The toolkit will be posted on the Dartmouth Toxic Metals Superfund Research Program webpage and the NH DES webpage. In addition we will be announcing the availability of the kit to local, regional, statewide and national groups as appropriate.

REFLECTIONS

Survey Results Inform Intervention Design and Implementation

During Year 1 of this grant we set out to design a survey that would elicit the testing and treatment behaviors for the population of private well owners living in New Hampshire and identify potential barriers to protective action. We utilized a series of focus groups to inform the development of our survey questions and garner feedback on the process of submitting the survey to NH residents.

Using our snapshot of private well owner behavior, as well as a criteria-based selection process, we selected three local interventions to test the effectiveness of these types of outreach activities based on specific parameters. While these did not directly address the populations of concern identified in our survey results, they did encompass those populations and yielded

significant results about the types of interventions that increase well testing rates and the ability to increase community capacity through community engagement.

Community Engagement

Community readiness to implement interventions and community partner involvement in planning proved to be crucial to the success of Year 2 interventions. The two towns with the most active community involvement are also the two towns with the highest number of test kits distributed and test kits returned. While we cannot quantify said involvement it should be considered when looking at results. Towns with limited or inconsistent community engagement and/or no history of addressing this issue seemed to struggle with intervention turnout, kit requests and communication distribution. While this can also be attributed to a variety of contributing factors, community engagement should be considered. Some town partners may have been interested in more involvement but, given their existing workload, were not able to commit to the project within our grant parameters.

Engaging community partners in the planning process also appeared to be fruitful. Our partners helped us correct erroneous assumptions made in Year 1 intervention planning. For example, we assumed that towns would be willing to send our communications out with their town tax mailings. Instead, no town was willing to do this and one suggested that doing so might be illegal. From this tip we were able to adjust our original plan and adapt to the needs of our partners.

Another benefit of community engagement is increased capacity. Five out of the six towns we worked with have expressed an interest in planning for future activities and all were grateful to participate in our grant project and have access to our communication materials.

Communication Materials

We crafted messages in our communication materials to address some of the concerns and barriers NH residents expressed in our Year 1 focus groups and statewide survey. Specifically we address the need for frequent testing, the fact that not all water contamination can be seen, smelled or tasted, that arsenic is common in NH and that testing can be cost effective and does not need to take a lot of time. We did not include treatment messaging for logistical reasons. These materials were well received by our partners and many are excited they will have access to these materials after grant completion.

Test Kit Returns

We did see an overall increase in test kits returned within our 6 implementation communities. In 2014, 37 kits were returned during our implementation period as compared to 73 returned in 2015. While this is a positive result the return rate of kits was around 15%. In speaking with partners from other parts of the U.S. a 25% return rate seems to be average. Therefore, a potential next step for the Dartmouth Toxic Metals Superfund Research Program would be the

exploration of this low kit return percentage. Action needed to complete, return and pay for the kit might be more daunting than requesting the kit itself.

Laboratory Data Storage System

Unfortunately, the Laboratory Data Storage System, designed to record information from private labs around New Hampshire which submit well testing data on a monthly basis, does not provide information on the location of the tests performed or information from previous years. Therefore, it was not useful for assessing the success of our interventions. As a result our evaluation of Year 2 interventions relies solely on DHHS Public Health Laboratory data. Nevertheless, we anticipate that the data storage system will be useful going forward in helping DES and partners measure the effectiveness of future outreach and intervention efforts.

Time Limitations

Results from this grant are promising but there is more work to be done. As with any limited funding opportunity, necessary restrictions can affect results. For example, we only had a 10 week window within which to implement our interventions. A number of community partners mentioned autumn events with high community participation which might have been good intercept locations. This also meant that communication materials were only distributed for a limited time, and for test kit returns to be counted they needed to be returned to the lab within our data collection window. It is likely that results from our work will continue well into the future, past the time we will be collecting the data. In addition we cannot measure whether our effort increased test kit requests or returns at private well water testing companies. Anecdotal information would suggest that community members may have contacted private labs, but again we cannot know for sure.

Increased Capacity for Future Work

As a result of this project we have increased our capacity for future work to increase testing and treatment of private wells by:

- developing baseline information and understanding from which to move forward;
- creating more of a community of private well owners and raising awareness of the need to test and treat;
- producing outreach materials with a recognizable brand which can be utilized for the foreseeable future;
- providing a figure for avoidable cancers and the number of potential cancers which could be used in messaging as warranted;
- creating new partners and networks (i.e., NH Cancer Registry, MtBE Bureau within NH DES);
- solidifying our relationships community leaders; and
- further establishing our credibility and that of NH DES and other partners.

CONCLUSIONS

- Focus groups held in Year 1 were effective in identifying most of the key points that ultimately arose in our statewide survey. Therefore, focus groups may be a quick and cost-effective way to understand community concern and beliefs around an issue such as water testing.
- Our survey provided more quantitative information on the population-level incidence of the beliefs and behaviors identified in our focus groups. In addition, some previously underappreciated issues were revealed by the survey, such as the relatively high mismatch between respondents' actual treatment system and their stated treatment needs. Similar studies in Maine corroborate this finding and have even verified the reported mismatch through home visits.[xviii]
- Both the focus group and the statewide survey revealed that most people obtain their information on well water quality and testing from local community sources.
- Statistical analysis of our interventions suggested that Testing Events were effective at increasing testing when preceded by Town Communications, but not when preceded by an Intercept Campaign. Additionally, the combination of Town Communications and Intercept Campaign alone were not effective in significantly increasing testing.
- The high level of effort required in implementing a combination of Town Communications and Testing Events, combined with the fact that most people rely on local sources for information on well water quality, suggest that future interventions intended to improve testing rates should likely focus on the local scale. While such interventions could benefit from state-wide coordination, centralized communication efforts are unlikely to be successful.
- In response to the conclusions reached above, we have developed a Well Water Community Action Toolkit. This toolkit was designed to provide resources and guidance to towns at any stage of readiness interested in supporting well water testing by its residents. We feel that distribution and ongoing support of town efforts is likely to be more effective than centralized state-level activities.

There are a number of questions that have been raised by this project that provide opportunities for future investigation, and which we hope will lead to future cumulative actions to increase private well testing and treatment to improve public health in New Hampshire.

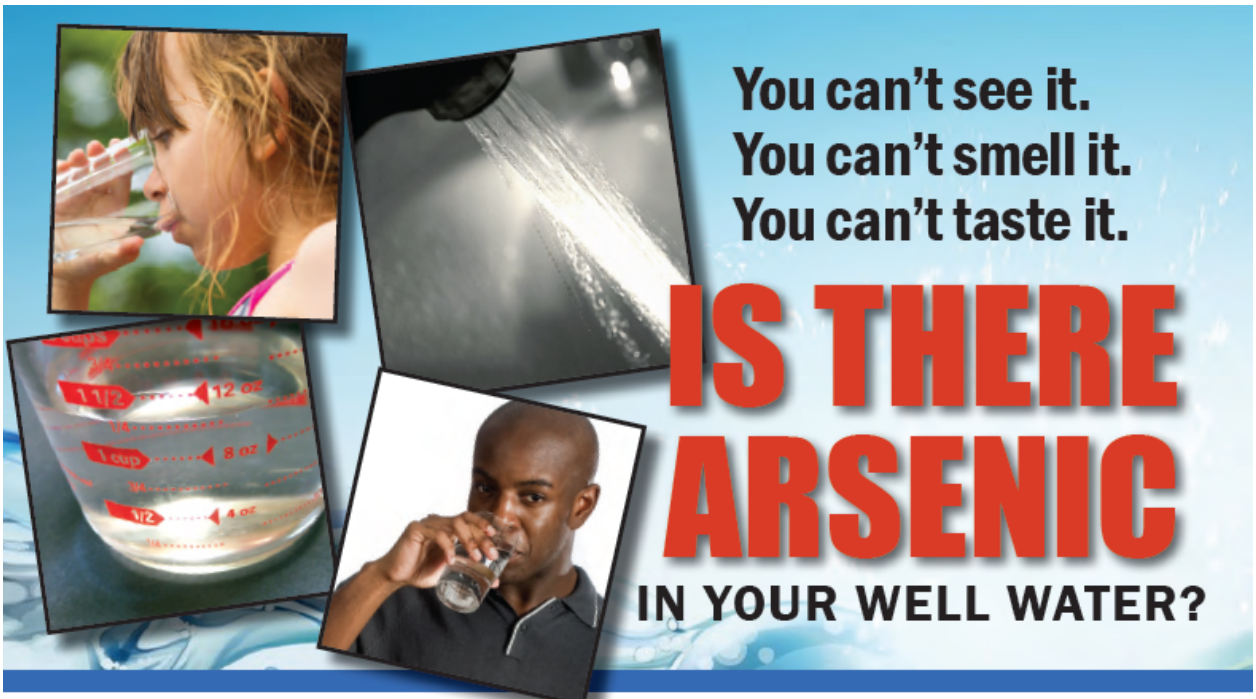
These include:

- Why did our survey find a relatively large proportion of people who have a treatment system that does not address their stated treatment needs? Are they misinformed about their treatment system or did they have an incorrect system installed?

- What can be done to reach people living in seasonal or multi-family homes, who seem to test their water at much lower rates?
- What is the reason for our low test kit return rate? Are there barriers that exist even once a well owner has their test kit in hand?
- How might testing rates change if well owners are better informed about the eventual cost and type of treatment systems that are available?

We have appreciated this opportunity to work with our partners at NH DES, NH DHHS and others on the Technical Advisory Committee to identify methods to improve the rate of private well testing and treatment in New Hampshire and add to the growing body of knowledge on this issue. We look forward to continuing our efforts with our partners to improve the health of New Hampshire communities by improving the quality of drinking water in private wells.

Appendix A: Infographic Communication Flyer



You can't see it.
You can't smell it.
You can't taste it.

IS THERE ARSENIC

IN YOUR WELL WATER?

1 in 5
homeowners' wells in New Hampshire contain unsafe levels of arsenic

$15
dollars
is all it costs to test your well water for arsenic

10
minutes
is all it takes to collect a water sample

3-5
years
is the recommended frequency for testing

ARSENIC IS COMMON IN WELL WATER.

- **Arsenic is present in New Hampshire well water** because of the state's granite and other types of rock.
- Arsenic in well water can cause **serious health issues over time**, such as heart problems and bladder, skin, and lung cancer.
- **Children are especially vulnerable** to the effects of arsenic in water.
- Everyone's wells need testing, so **do not rely on the results of your neighbor's test.** Arsenic levels vary from house to house.
- **Common treatment methods, such as boiling, pitcher filters, or a water softener, do not remove arsenic.**
- There are **many resources available** to help! We suggest you start at: http://www.dartmouth.edu/~toxmetal/arsenic

TESTING YOUR WATER IS EASY.

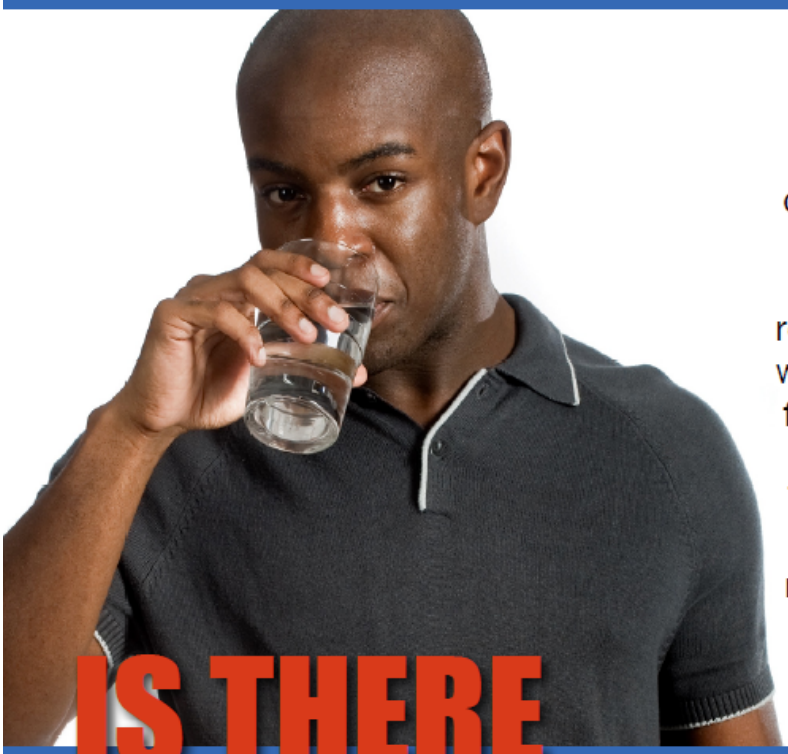
- The **first step to keeping your family safe** is to test your well water for arsenic and other contaminants.
- The cost to test your water ranges from about **$15 for just arsenic to $85 for a standard package** of tests of the most common contaminants.
- **Sample collection bottles are easily available** from state or private labs. Bottles **can be mailed to you** and samples **can be mailed back**. Directions will be included in your kit.
- If testing shows that you have unsafe levels of arsenic, there are **reliable options** to address it.
- For a list of certified labs, visit: http://www2.des.nh.gov/CertifiedLabs

TEST YOUR WATER TODAY, AND THEN AGAIN EVERY 3 TO 5 YEARS.

Visit http://www.nhwellwatertest.org/

Appendix B: Testimonial Communication Flyer

You can't see it. You can't smell it. You can't taste it.



"I had no idea the water we were drinking and cooking with was unsafe. I have lived in my house for 10 years and didn't realize I had arsenic in my water that could affect my family's health. It looked, smelled and tasted fine. The fix was easy and not too expensive. I feel so much better knowing the water is safe to drink."

IS THERE ARSENIC IN YOUR WELL WATER?

ARSENIC IS COMMON IN WELL WATER.

- **Arsenic is present in New Hampshire well water** because of the state's granite and other types of rock.
- Arsenic in well water can cause **serious health issues over time**, such as heart problems and bladder, skin, and lung cancer.
- **Children are especially vulnerable** to the effects of arsenic in water.
- Everyone's wells need testing, so **do not rely on the results of your neighbor's test.** Arsenic levels vary from house to house.
- **Common treatment methods, such as boiling, pitcher filters, or a water softener, do not remove arsenic.**
- There are **many resources available** to help! We suggest you start at: http://www.dartmouth.edu/~toxmetal/arsenic

TESTING YOUR WATER IS EASY.

- The **first step to keeping your family safe** is to test your well water for arsenic and other contaminants.
- The cost to test your water ranges from about **$15 for just arsenic to $85 for a standard package** of tests of the most common contaminants.
- **Sample collection bottles are easily available** from state or private labs. Bottles **can be mailed to you** and samples **can be mailed back**. Directions will be included in your kit.
- If testing shows that you have unsafe levels of arsenic, there are **reliable options** to address it.
- For a list of certified labs, visit: http://www2.des.nh.gov/CertifiedLabs

TEST YOUR WATER TODAY, AND THEN AGAIN EVERY 3 TO 5 YEARS.

Visit http://www.nhwellwatertest.org/

Appendix C: Infographic Communication Postcard

ARSENIC IS COMMON IN WELL WATER.

- **Arsenic is present in New Hampshire well water** because of the state's granite and other types of rock.
- Arsenic in well water can cause **serious health issues over time**, such as heart problems and bladder, skin, and lung cancer.
- **Children are especially vulnerable** to the effects of arsenic in water.
- Everyone's wells need testing, so **do not rely on the results of your neighbor's test.** Arsenic levels vary from house to house.
- **Common treatment methods, such as boiling, pitcher filters, or a water softener, do not remove arsenic.**
- There are **many resources available** to help! We suggest you start at: http://www.dartmouth.edu/~toxmetal/arsenic

TESTING YOUR WATER IS EASY.

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- The cost to test your water ranges from about **$15 for just arsenic to $85 for a standard package** of tests of the most common contaminants.
- **Sample collection bottles are easily available** from state or private labs. Bottles **can be mailed to you** and samples **can be mailed back**. Directions will be included in your kit.
- If testing shows that you have unsafe levels of arsenic, there are **reliable options** to address it.
- For a list of certified labs, visit: http://www2.des.nh.gov/CertifiedLabs

TEST YOUR WATER TODAY, AND THEN AGAIN EVERY 3 TO 5 YEARS.

Appendix D: Well Water Testing Kit Request Form Questionnaire

New Hampshire Well Water Testing Kit Request

Please complete below and drop in the mail to request your well water test kit.

Name _____

Address _____

City _____ **State** _____ **Zip** _____

E-mail Address _____

Or, submit your request at www.NHwellwatertest.org

How did you hear about us?

- ☐ Event or information table in my town
- ☐ Mail, email, or other written notice
- ☐ Other: _____

Have you had your water tested in the past?

- ☐ Yes
- ☐ No
- ☐ Not sure

If yes, when was your last test? _____

Did that test include arsenic?

☐ Yes ☐ No ☐ Not sure

Why did you request a well water testing kit today?

- ☐ I received new information on the potential health risks of contaminants in well water.
- ☐ I had been meaning to test and was reminded to do so.
- ☐ I learned it was more convenient or less expensive than I expected.
- ☐ I received new information on the importance of testing well water regularly.
- ☐ I was influenced by a friend, family member or other acquaintance.
- ☐ Other _____

If no, or not in the last 5 years, why haven't you had your water tested?

You may mark more than one.

- ☐ I wasn't aware that I should.
- ☐ I didn't know what to test for.
- ☐ I didn't know how to go about having the water tested.
- ☐ I didn't think I would know how to act on the test results.
- ☐ My water was tested before I moved in.
- ☐ I meant to have it tested but never got around to it.
- ☐ I have not had any health problems caused by drinking the water.
- ☐ My water looks, smells, and tastes clean.
- ☐ I already have a water filter or treatment system.
- ☐ Other _____

Test kit consists of one or more water sample collection bottles, as well as instructions and forms, that you will need to return to the NH state lab in person or by mail.

REFERENCES

[i] A survey by NH Department of Health and Human Services in 2006 found 44.4 percent of households using private wells. Source: JoAnne Miles, September 7, 2007, Drinking Water Source Data Brief, N.H. Environmental Public Health Tracking Program. In 2014 NHDES revised the estimate to 46 percent as of 2010 based on new wells drilled since 2006.

[ii] DeSimone, L.A., P.A. Hamilton, and R.J. Gillom, Quality of Water from Domestic Wells in Principal Aquifers of the United States, 1991-2004, in National Water-Quality Assessment Program, Circular 1332. 2009, U.S. Geological Survey. p. 1-48.

[iii] Miles, J., Drinking Water Source Data Brief, N.H.E.P.H.T. Program, Editor. 2007.

[iv] Naujokas, M.F., et al., The broad scope of health effects from chronic arsenic exposure: update on a worldwide public health problem. Environmental Health Perspectives, 2013. 121(3): p. 295.

[v] Anders, W.M., R. J. Bull, K. P. Cantor, D. Chakraborti, C. Chen, A. B. DeAngelo, D. M. DeMarini et al., Some drinking-water disinfectants and contaminants, including arsenic. World Health Organization, 2004. 84.

[vi] ATSDR. Priority List of Hazardous Substances. October 25, 2013. Available from: http://www.atsdr.cdc.gov/spl/.

[vii] USEPA. Arsenic in Drinking Water. September 17, 2013. Available from: http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/.

[viii] Montgomery, D.L., et al., Arsenic Concentrations in Private Bedrock Wells in Southeastern New Hampshire, in U.S.G.S. Fact Sheet 051-03. 2003. p. 1-6.

[ix] Peters, S.C., et al., Arsenic occurrence in New Hampshire drinking water. Environmental Science and Technology, 1999. 33(9): p. 1328-1333.

[x] Ayotte, J.D., et al., Estimated Probability of Arsenic in Groundwater from Bedrock Aquifers in New Hampshire, 2011. 2012. p. 25.

[xi] Montgomery, D.L., et al., Arsenic Concentrations in Private Bedrock Wells in Southeastern New Hampshire, in U.S.G.S. Fact Sheet 051-03. 2003. p. 1-6.

[xii] Ayotte, J.D., et al., Estimated Probability of Arsenic in Groundwater from Bedrock Aquifers in New Hampshire, 2011. 2012. p. 25.

[xiii] Novokowski, K., et al., Water Well Sustainability in Ontario. 2006, Ontario Ministry of the Environment.

[xiv] Flanagan et al. Dissemination of well water arsenic results to homeowners in Central Maine: Influences on mitigation behavior and continued risks for exposure. *Science of the Total Environment*, 505, 1282-1290.

[xv] Jones, A.Q., et al., Public perception of drinking water from private water supplies: focus group analyses. BMC Public Health, 2005. 5.

[xvi] Oetting et al. Assessing Community Readiness for Prevention. International Journal of the Addictions. 1995, 30(6). pp. 659-683.

[xvii] Stanley, Linda R. Community Readiness for Community Change.Tri-Ethnic Center Community Readiness Handbook. 2nd edition.Tri-Ethnic Center for Prevention Research, Colorado State University, 2014.

[xviii] Flanagan, S. V., Marvinney, R. G., Johnston, R. A., Yang, Q., & Zheng, Y. (2015). Dissemination of well water arsenic results to homeowners in Central Maine: Influences on mitigation behavior and continued risks for exposure.*Science of The Total Environment*, *505*, 1282-1290.